Call for Research Project Financial Support

TECHNICAL REPORT FOR THE I+D PROJECTS TYPE A and B

ABSTRACT (also filled out in Spanish**)**

PRINCIPAL INVESTIGATOR: Casiana Muñoz Tuñón

TITLE: Starburst in Galaxies (third edition) – ESTALLIDOS3

SUMMARY (short and to the point including only very relevant aspects and the objectives):

The **central objective** of this project is **the theoretical and observational study of starbursts, and their impact on the galaxies hosting them**. Our aim is to define the extent of these bursts as well as the key parameters that allow their feeding, leading to the birth of future generation of stars. To this end a carefully selected sample of starburst galaxies has been chosen covering a wide range of properties, from nearby spiral galaxies hosting nuclear starbursts, through those in dwarf galaxies, Giant HII regions in spiral and irregular galaxies, and including galaxies hosting active nuclei. We differentiate between isolated objects that behave as closed ecosystems from those, like galaxy clusters or groups, in denser environments. The later will have their star formation rates and evolution conditioned by the environment. The proposal is structured in programs, each one containing a well-defined sample of objects. We have also defined a master galaxy sample containing archetypical objects from each subsection that will be studied by the whole group, in the entire wavelength range. We will carry out X-Ray, UV, visible, IR and radio observations, with both ground-based and space telescopes.

In this third edition of the ESTALLIDOS project, we add to new objectives to the original one of studying massive star formation**: i)** as a team we will prepare and carry out competitive **key programs** in order to achieve enough observing time in present and future large scale **international facilities** (e.g. VLT, GTC or GTM); and **ii)** at the same time we will **strengthen our activity in public outreach and diffusion of science new**s via the design of an efficient scheme to disseminate the results of the project, in coordination with the efforts of our respective institutions. With these two new objectives we could put in practical terms our participation in the **Consolider-Ingenio2010: *Ciencia con el GT* project,** for which ESTALLIDOS constitutes a central component.

TÍTULO DEL PROYECTO : Estallidos de Formación Estelar (3ª Fase)

RESUMEN (debe ser breve y preciso, exponiendo sólo los aspectos más relevantes y los objetivos propuestos):

El **objetivo central** del proyecto es el **estudio observacional y teórico de brotes masivos de formación estelar, o *starbursts*, y su impacto en galaxias**. Es nuestra intención el definir el alcance de estos eventos así como el encontrar los parámetros que llevan a la realimentación, o feedback, y así a la formación de futuras generaciones de estrellas. Para ello ha sido seleccionada una muestra de starbursts que cubre un amplio rango, desde los nucleares en galaxias espirales grandes cercanas a los encontrados en galaxias enanas, pasando por las regiones HII Gigantes en espirales y galaxias irregulares y los que suceden en galaxias que además tienen un núcleo activo. Diferenciamos objetos aislados y que por tanto constituyen un ecosistema de aquellos que se encuentran en entornos más densos, galaxias en cúmulos o en grupos, que ciertamente pueden ser determinantes en la formación y evolución de los cúmulos de estrellas masivas (starbursts). Cada uno de los apartados que planteamos tiene su muestra de objetos característicos. Hemos definido también una muestra común que comprende ejemplos típicos de cada clase y que será estudiada por todo el equipo con observaciones multifrecuencia. Se harán observaciones en Rayos X, UV, visible, IR medio y lejano y radio usando tanto telescopios en tierra como satélites. Nos proponemos además ampliar la muestra de objetos sustancialmente para realizar, además de los estudios detallados en las muestras propias, un uso masivo de bases de datos que nos permitirán alcanzar resultados muy robustos estadísticamente.

En esta tercera edición de ESTALLIDOS, al estudio multi-frecuencia, observacional y teórico, de la formación estelar masiva, objetivo matriz y central del equipo, **añadimos dos grandes objetivos: i)** abordaremos la realización de **programas clave** competitivos que, "como un equipo", consigan la asignación de tiempo de observación **en las grandes instalaciones internacionales** (e.g. VLT, GTC, GTM); y **ii)** al mismo tiempo **consolidaremos la actividad de divulgación y difusión** diseñando un esquema fluido de elaboración y difusión de noticias que, coordinado con el esfuerzo de nuestros respectivos centros, puntualmente difundan los resultados del equipo. Con estos dos nuevos objetivos podremos desarrollar en la práctica nuestro compromiso de participación en el proyecto **Consolider-Ingenio2010: "Ciencia con el GTC"** ,en el que ESTALLIDOS constituye un componente central.

2. INTRODUCTION

This introduction must include aims, background, present status of the relevant scientific and technical knowledge (with references), and national and international groups working on topics directly related to the proposal.

We form a group that works in a coordinated way within the framework of the "National Program for Astronomy and Astrophysics". Defining our science and our objectives was our first task, and establishing a coordination protocol was a real challenge. We set up a working plan for scientific meetings – which were the skeleton of our coordination activity - where, besides presenting results on specific topics, we also discussed in a more general way the various scientific subjects we were studying, and the progress of our group. The proceedings of our yearly workshops have been published in electronic format, and made available through our Web site (http://www.iac.es/proyect/GEFE/estallidos/) by the workshop organizers, who were in charge of collecting and revising the contributions of all of the workshop participants. We would like to emphasize that this procedure is somewhat wearisome (ESTALLIDOS includes more than 40 researchers), and taking care of the workshop logistics, elaborating the scientific program, and editing the proceedings required a remarkable efforts (in which all ESTALLIDOS members did their share of work). We thought that this was the best way to share information among all group members, to set new challenges, to foster direct collaborations among team members sharing common interests and research subjects, and, all in all, to keep the group united. This scheme has worked out very well, and we will keep using it: as a matter of fact, we know it is being used by other groups.

The next challenge, now that we are half-way into the second phase of ESTALLIDOS (that will finish by the end of 2007) is how to incorporate new goals that, on the one hand, keep the team *alive*, and on the other hand, will allow us to pass on our experience. In order to do so, the GENERAL AIMS have widen. Only objective 1 corresponds to what ESTALLIDOS 1 and ESTALLIDOS 2 have been, and it represents the science made by our team. We add two more objectives resulting from (2) the challenges of doing the best and most competitive science for large telescopes, and (3) the need to popularize our science, a commitment that we take as a team that is *paradigmatic* due to variety topics dealt with, its long history, its experience and cohesion. In other words, ESTALLIDOS must be an example in this respect.

Moreover, ESTALLIDOS has participated actively in the elaboration of the CONSOLIDER-Ingenio 2010 proposal, *First Science with the GTC* (September 2006-September 2011), which, led by the GTC Project Scientist Jose M. Rodríguez Espinosa (member of ESTALLIDOS since its beginnings), was one of the 15 successful proposals in all disciplines. The participation of ESTALLIDOS in CONSOLIDER-Ingenio makes up two of the five blocks of CONSOLIDER: science with the GTC (P.I. Casiana Muñoz-Tuñón) and public outreach with GTC (J. Miguel Mas). With the two new objectives included in ESTALLIDOS (third phase) we will fulfill our commitment as a team in the CONSOLIDER project and we will establish in a unambiguous way our participation so as to assure full synergy.

However, objectives 2 and 3 are not just limited to those activities related to Consolider- Ingenio; we also propose, following the recommendations set out by the panel of experts who monitored our project, to participate in and lead research networks, UE-wide programs, programs with Latin America ...; in short, to take advantage of the status already reached by ESTALLIDOS in the international community in order to establish our research activity in an international setting.

General background

We know since the 70's that episodes of vigorous star formation activity take place in many galaxies (Searle et al. 1973). The intensity of such episodes is so high as to make their duration quite short, since the amount of available gas in these objects does not permit to maintain for a long time the observed star-formation rate. Because of the intensity and short duration of these events, they were called starbursts. The presence of a large number of young stars, in all the mass range, with similar ages and metallicities, and all concentrated in a relatively small volume, makes these regions excellent laboratories to study the feedback process in massive star formation: the processes of formation and evolution of massive stars, their interaction with the environment and their impact on the evolution of galaxies.

The availability since the 80's of space observatories sensitive to the UV range, and the improvements in optical and infrared instrumentation during the last years, have allowed us to expand our knowledge of these regions. As we will explain in detail later on, the members of our research team have contributed significantly to these studies, both on the observational side and on the theoretical modeling of the star-formation processes and its effects, and also on the development of evolutionary synthesis models of stellar populations and physical observables.

Despite all the effort made by the astronomical community, no general well developed predictive theory on star formation in galaxies exists yet. A glance at the scientific literature in the last ten years shows a wide range of phenomena which go collectively under the name of "Stellar Formation". We are not looking for a definitive answer to the problem of stellar formation but, rather, we are approaching it with different methodologies and common objectives. With this aim in mind, we have gathered a group of experts working on all of the different aspects of star formation in galaxies.

In ESTALLIDOS we study how the star formation is organized, what kinds of patterns can be distinguished, and where and how it takes place. The approach we have selected to tackle the problem involves studying different spatial scales in the nearby universe. Each one of these different spatial scales requires a different methodology and provides different observables; the challenge is to extract from all this vast information those common patterns that allow us to develop simple schemes. To this end, we will make use of a large database and will carry out new observations in many wavelength ranges, extensively applying the theoretical models developed by our group.

In what follows we present a Coordinated Project in which the Instituto de Astrofísica de Canarias, the Instituto de Astrofísica de Andalucía, the Universidad Autónoma de Madrid, the Centro de Astrobiología (CSIC-INTA), the CIEMAT y the XMM-Newton Observatory of the European Space Agency participate. This project is the continuation of another project currently running, and approved two years ago (AYA2004_08260_C03), which in turn was the continuation of the original ESTALLIDOS (AYA2001-3939-C03), and has been joined by new members and research centers with complementary experience.

We benefit from the great advantage of being a large group with an important experience on the different techniques required for the study; the observational methods and the theoretical modeling. The geographic location of the different components of our group is not a major problem. Our group has been working together for several years, and we have been able to tackle many research projects for more than a decade. We have been working in the framework of ESTALLIDOS since 2001, and in the present edition three new Juan de la Cierva and two Ramón y Cajal fellows have joined us, who will certainly provide new momentum and enthusiasm. In order to make the most out of these new re-

sources, line 2 of the present project "Science for large telescopes" will be organized by the Ramón y Cajal fellows with the collaboration of the Juan de la Cierva fellows and, of course, of the PIs of ESTALLIDOS.

We have divided the scientific activities proposed by ESTALLIDOS into six blocks or programs (two of the programs which were developed in ESTALLIDOS 2 have been merged into one block named *modeling*). In Section 4, *methodology and working plans,* details the Institutes and the PIs responsible for each block, together with the members more directly involved. All programs have their own objectives and goals; however the project as a whole has been conceived as a puzzle which, with the work done by the whole group and the joint analysis of partial results, will lead us to our final objective: the identification of the critical parameters in the formation and evolution of bursts of star formation. The objectives we set come from the ones proposed in ESTALLIDOS 1 and ESTALLIDOS 2 after being redefined on the basis of the new scientific results (presented in Section 3.2, and in Appendix 3).

Program 1: Self consistent modeling of ionized regions.
This program is planned as a tool for the rest of the activities. The purpose is to include the stellar population in the analysis – population synthesis models, physical properties, photoionization models, chemical abundances – to build a series of theoretical models based on our knowledge of the evolution of massive stars. On the one hand, evolutionary population synthesis models, developed by the team during the last years, are used. They provide a series of predictions of different observables in a wide wavelength range (from X rays to radio). Comparing predicted and observed values it is possible to restrict the properties of massive star clusters: e.g., age, population structure, initial mass function, star formation rate or amount of mechanical energy deposited in the interstellar medium. On the other hand, any mechanism describing the formation of massive stars must take into account the ionization of the surrounding material due to the energetic radiation they emit. The transfer of this radiation, i. e., its interaction with the gas, configures the ionization structure of the gas itself, whose knowledge makes it possible to obtain properties as important as the gaseous chemical abundances, its spatial distribution, and can even provide very relevant information on the properties and evolutionary stage of the stars responsible for the ionization. This problem has been exhaustively studied by means of the building, development and application of numerical photo-ionization codes. In our case, we will use a new tool, the MOCASSIN code, which we have been implementing as part of the ongoing project (ESTALLIDOS 2). This code solves for the ionization structure of the gas in three dimensions, hence abundances can be determined simultaneously and self-consistently together with other parameters also relevant for ESTALLIDOS, such as the structure of the stellar population and the impact of the star formation processes at different scales and in different environments.

These techniques will be applied to all the programs which make up this project when the interpretation of the observational data will require so. Besides, they will be used, in particular, to calibrate in a homogeneous manner different tracers of star formation used in the past, such as the intensity of different emission lines, the UV continuum, the X-ray emission etc. We propose to establish a homogeneous theoretical calibration to all commonly used parameters, which ensures that the star formation rates derived at the different cosmological distances are consistent with one another, taking into account that in each redshift range a different tracer has to be used depending on observing possibilities.

Program 2: Chemical evolution of galaxies
The chemical evolution is one of the basic tools used in the study of galaxies. The elemental abundances of the interstellar medium are determined by the masses ejected from stars during their evolution and death. Therefore, its relative composition is directly related to the star formation histories which

produced those elements. The combination of different techniques, like the use of chemical evolution models together with evolutionary synthesis models, has proved to be a powerful tool to discriminate among different evolutionary histories. The idea is to apply these techniques for the interpretation of data of different galaxy types, in particular dwarf galaxies and blue compact galaxies (BCG), both metal deficient, and hence supposed to be going through their first star formation episode. This, together with the low amount of observed gas, implied the existence of galactic winds. We now know that in these types of galaxies there is an underlying population with an age of several hundred million years, and therefore other alternatives must exist. They will be explored in this project in order to explain current observations. In particular, we will study what the history of star formation has been in BCG (isolated, recurrent bursts or low intensity continuous star formation). On the other hand, we will carry out an analysis of the available data for dwarf galaxies to determine which ones require the existence of galactic winds, and if this is environment dependent, or it is rather related to the mass and morphological type. In both cases we will explore the different hypotheses through the application of models that combine chemical evolution, evolutionary population synthesis and gas photo-ionization in a self consistent manner. We will keep these tools up to date, in particular the chemical evolution code in order to take into account the possible improvements that may arise.

Program 3: Structural parameters of galaxies

In order to perform a self-consistent analysis of starbursts in galaxies it is essential to know the medium in which they are generated, and this is clearly defined by the galaxy hosting them. Only knowing the structure, kinematics, and dynamics of the host galaxy can we advance in the knowledge of the mechanisms that produce the feedback of violent star formation. In this program we will make a detailed study of the host galaxy, by analyzing the morphological and dynamical structure of a nearby galaxy sample, including the common target of our coordinated project. It is therefore a program useful for the rest of the programs of our project. We will take a step forward by developing two-dimensional models that will allow us a better identification and characterization of the structure of galaxies hosting starbursts. In order to do that, we will use optical and IR photometric observations that will provide information about the different kinds of stellar populations that make up the galaxy. These populations are basically distinguished by the stellar type composing them, their spatial distribution, and their kinematics.

The method of two-dimensional fitting of the structural components of galaxies with star formation will also be applied to galaxies where the star formation is not so important. In particular, we plan to make a detailed study of the structural parameters of a wide sample of galaxies in nearby clusters and determine the differences between them and field galaxies. This will allow us to know the influence of the environment on the formation and evolution of galactic components: bulge and disc. This work will be carried out in close collaboration with the program 5 of this project, thus showing the transversal character of program 3.

We also propose carrying out studies of structural components in barred galaxies. The inclusion of this component in the photometric decompositions greatly complicates the fits and has not been yet adequately treated. Based on our own previous experience on the surface brightness profile fitting of bright barred galaxies, we intend to generalize it and to develop a new 2D code for the fitting of this galactic component. This will allow us to study the photometrical parameters of bulges, discs and bars of a wide sample of barred galaxies and compare them with those of unbarred galaxies and also with the results from numerical simulations of barred galaxies. In particular, we want to know the effect of the bar on the formation of bulges and in the triggering of episodes of massive star formation. Besides, we will apply this code to the study of the photometric parameters of a sample of barred dwarf galaxies present in

galaxy clusters. The study of the structural parameters of these galaxies, together with their dynamics (bar velocity pattern) will allow us to constrain their origin and evolution.

Program 4: Massive star formation feedback

The concept of galactic super wind was defined following the basic concepts of the evolution of stellar remnants produced by multiple supernova explosions, and applying it to those systems in which a large number of stars, hundreds or thousands of which are massive stars, have formed (Heckman et al. 1990). Galactic super winds have become however a wild card in present day astrophysics, and they are invoked as the responsible mechanism of the presence of metals in the intergalactic medium, without the necessary rigour.

In ESTALLIDOS we have made important advances in the hydro-dynamical modeling of galactic super winds which can be summarized in two results. Firstly, the free expansion of the wind material ejected by stars suffers radiative temperature losses (contrary to what had been assumed); as a consequence, classical models cannot explain the extended emission (kiloparsec size) of X rays. And secondly, we have implemented a new paradigm in the models (references in Annex 3). The Hubble Space Telescope (HST) is showing how starbursts are composed by a set of compact systems which are called star or super star clusters (SSCs). We have considered this possibility in our numerical works finding that, when these substructures are considered, extended X ray emission is obtained, as well as a filamentary structure of galactic super winds (M82 type). Besides, the resulting fluxes are self collimated due to the interaction of the winds with nearby complexes. In the program of ESTALLIDOS, we have studied of the mechanisms of super wind triggering, the confinement of massive star formation, and the effect of super star clusters.

We have also advanced in the knowledge of massive starburst from observation. From high resolution images of the HST archive, we have catalogued the population of nearby SSCs, such as those of M 82, and this study allows us to define the observational conditions, density and luminosity, of the SSC population capable of originating winds like those of M 82. This study is being extended to starburst objects, with available adequate HST observations. A preliminary object compilation is already available.

In the third phase of ESTALLIDOS, we wonder under which conditions the star formation feedback will be positive or negative. The implications of the answer to this question are far-reaching. The negative feedback – as is the case for galactic super winds – will contribute to the enrichment of the intergalactic medium and will make an imprint on the host galaxy. The cases of positive feedback, of extreme transcendence, could provide a key element to understand galaxy formation in primordial epochs, and will enable us approaching the metallicity-luminosity relation from another point of view.

Program 5: Environmental effects on star formation activity

There is an open debate on the influence of the environment on galactic evolution (in the specialized literature this debate is usually refereed to as *nature versus nurture*). Nowadays we know that the environment where galaxies are located has a decisive influence on many processes regulating active star formation. The ambient parameters that can act on active star formation, and that have to be taken into account for a proper understanding, are related to the density of the environment. From a theoretical point of view, it is expected that galaxies located inside a region of high density, like a cluster or a group, may be affected by tidal forces that produce a re-distribution of their material; besides, the gas component of galaxies can suffer stripping or/and evaporation due to interactions with its surroundings.

The relatively high density of the intergalactic medium (IGM) together with the high encounter probability in rich clusters, favours the selective loss of gas, specially from halos and discs of late type galaxies, as well as the compression of molecular clouds and the transport of gaseous material toward the galactic nuclei. Besides, interactions and mergers of galaxies in clusters sweep the galactic material (star and gas) which become part of the intergalactic intracluster gas. This material produces a very low surface brightness component, the so called diffuse light, already detected in some nearby clusters and groups.

The present program will study influences of the environment on the star formation rate (SFR) in galaxies. In particular, we will concentrate on galaxy clusters, the biggest self-gravitating structures known, where the environment density is highest and therefore its effects can be measured with the greatest precision. The existence of a dense environment can give rise to interactions among galaxies or between galaxies and the intergalactic medium itself, which would alter the SFR along their evolution. On the one hand, we will approach the study of the present SFR in cluster of galaxies, which will provide information about the role of interactions in star formation. On the other hand, we will try to go further and study the star formation history (SFH) in order to understand galaxy evolution from their birth to the present epoch. The modeling of the galaxies will be made under program 3.

Another important aspect which will be tackled in this program is the diffuse light in a sample of nearby clusters. This study will provide relevant information for the dynamical state of nearby galaxy clusters.

Program 6: Star formation under extreme conditions

During the last years there have been remarkable advances in our understanding of the structure and physical properties of active galactic nuclei, especially thanks to X ray observations provided by Chandra and XMM-Newton missions. By combining the spatial and spectral resolutions of both missions it has been possible to study the gas properties up to scales smaller than 100 pc, and even of a few parsec in some cases (Colina et al 2002), thus allowing a better knowledge of the relation between active nuclei and the massive star formation processes that take place in their surroundings. The ubiquitous presence of super massive black holes (SMBH) in the centres of galaxies in our local environment (Magorrian et al. 1998) suggests that the formation of a SMBH constitutes an integral part in the formation of the spheroidal component of galaxies. The “ignition” of these nuclear super massive black holes, becoming an active nucleus, should take place during the periods in which there is accretion of external material. This accretion process, which apparently is not constant in time, should also imply the starting up of violent processes of star formation at a given distance from the nucleus, so that in many cases a relation, at least temporal, should exist between both phenomena: the formation of a great number of massive stars would release a great amount of material through winds and supernova explosions in a relatively short time (a few million years). This gas, accelerated by the starburst itself to relatively high velocities, could flow towards the nuclear SMBH, activating it during the duration of the accretion. On the other hand, if the accretion of material by the nucleus is fast, the release of mechanical energy by the nucleus, once active, could induce star formation processes in the nearby gas.
At any rate, SMBH and violent star formation processes should have co-existed in galactic centres in the past, even more frequently than observed at present. Therefore, the understanding of the physical processes which governed the formation of SMBH and galaxies, in the first epochs of the Universe, is intimately related to our understanding of the starburst-AGN connection. This places the study of violent star formation processes and the nuclear activity in a more general context such as the formation and evolution of galaxies.

The ESTALLIDOS team joins together many of the researchers in our country with expertises and interest in the study of violent star formation in the nearby Universe. It also includes aclose collaborators of foreign institutions. The group already has well established synergy between theory and observation; during our long experience as a team, new discoveries which impulse new ideas occur alternatively in these two fronts. At times new data and new observations have been the seed for new lines of research and, in other occasions, theoretical models have established new paradigms that we have supported with observations. The ESTALLIDOS team is by now rather large; through its lifetime new members and institutions have incorporated and it has also given rise to some independent projects that originally were part of the collaboration. As a result of the work of ESTALLIDOS 1, some of the aspects turned out to be very rich and methodologically differentiated. As a consequence, they were approached in a formally independent way (IP: Dr. E. Pérez). Also, from ESTALLIDOS2, a new independent project is detaching: the one relative to stellar complexes in our galaxy and neighbouring galaxies, methodologically well differentiated. The project is led by Dr. E. Alfaro and is also applying for funds in this round.

There are several groups in our country working in aspects related to ours, and that we expect will benefit from the results obtained by our team. Listing them all would be difficult, and we will limit ourselves to those which also participate actively in CONSOLIDER-Ingenio and with whom we necessarily must establish fluent channels of communications. We are referring to: the group of “surveys at different redshifts” from the Universidad Complutense de Madrid (UCM) (Drs Zamorano and Gallego et al.); the group of “studies of star formation at high z” (Goya; Drs Gallego and Guzmán et al.); the group of “studies of massive stars” (Dr A. Herrero et al.) and the OTELO survey of emission line objects part of the OSIRIS instrument of the 10m telescope (Dr J. Cepa et al.).The exchange of information with these groups will be made in the context of the project CONSOLIDER-Ingenio. The funding for the transverse exchange of information activities between ESTALLIDOS and the other science groups of CONSOLIDER is not budgeted in this project since it already has enough funds allocated from CONSOLIDER.

To finish, we would like to mention that, the star formation process, its feedback and impact in building up "our Universe" is a "hot" topic. In the international context there are groups spread all over the world, at different Institutions, which are carrying out studies on the impact of massive star formation and related issues. It would be impossible to list all them here. Let us just mention few European Networks, where scientific aims somehow related to the topic of ESTALLIDOS can be found, such as the large OPTICON network for astronomy (P.I. Prof G. Gilmore; including research networks: E3D, NUVA, ELT) and also the MAGPOP network (P.I. Prof. G. Kauffmann). Some of the members of these consortiums also participate in the CONSOLIDER-ingenio project, so that future collaboration and information exchange are assured, and it will be channelled in the framework of CONSOLIDER.

Note: The bibliographical references are listed at the end of this memory (annex 2). We also include those which are result of our work in ESTALLIDOS 1 and ESTALLIDOS 2 (annex 3), which also make up to the context for the work we are proposing for the next three years.

3. OBJECTIVES OF THE PROJECT

- **3.1** Provide a brief description of the rationale for carrying out the research and, if appropriate, also provide the **starting hypothesis** that supports the objectives of the project

The fundamental objective of this project (OBJECTIVE 1) is to determine the parameters which characterize the processes of intense star formation in different environments. We intend to better understand the mechanisms triggering these bursts, their impact on their surroundings, and to determine the feedback cycle that we think exists. We start from the hypothesis that a massive burst (more than 10^5 $M_\odot$) cannot be considered as the sum of a set of individual HII regions, like those existing in spiral galaxy arms. For these bursts to take place, a large amount of gas has to accumulate in a relatively small volume, without any relevant star formation occurring during this accumulation process. Thus, the star formation during these bursts is practically simultaneous, such as has been shown by different studies during the last years, including those by our own team. Nevertheless, HST results have recently shown that stars form in clusters and super clusters, apparently according to a certain mass function. We consider that the physics of the formation and evolution of stars in these clusters and super clusters is universal, and this allows us to apply the techniques which have been developed for smaller star forming regions, in which our team is expert: population synthesis, photoionization models, hydrodynamical models, chemical evolution models. However, the high density of these clusters and their strong impact on their surroundings determines a structure very different from what is observed at a small scale and that requires a specific modeling. Besides, in order to understand the feedback process it is necessary to establish the relationship between the location and properties of the bursts and the structure of the galaxies where they take place. We must characterize the two-dimensional structure of these objects, generated through the history of each galaxy.
In addition to the original goal of ESTALLIDOS – the science relative to massive star formation –, we are including in this third edition two more objectives that we consider important in the present moment of the Spanish astronomy and that, furthermore, will stimulate our collaboration and rise its standards. These are OBJECTIVE 2: to define competitive cases for the exploitation of large telescopes (ESO-GTC, GTM) which can be part of international collaborations, and OBJECTIVE 3: to assure the correct diffusion of scientific results of the team and, in parallel, to develop schemes and proposals for the outreach of science both to the general public and through what is referred to as *high level vulgarization*.

- **3.2. Background and reprevios results** by the applicant team or by others supporting the starting hipótesis.

The project presented here corresponds to the third edition of the coordinated project ESTALLIDOS, starting in December 2001 and still running (PNAYA2001-3939-C03). The antecedents of the central topic of this proposal are given in section 2 of this report; another overview can be found in the project web page: http://www.iac.es/project/GEFE/ESTALLIDOS , where the workshops held by the collaboration are detailed. ESTALLIDOS is also a key part of the project CONSOLIDER-Ingenio 2010 *First Science with GTC*.
Some of the results of the previous editions of the project were recently presented in a public session on request of the Astronomy and Astrophysics National Program Manager. The summary is presented next. A detailed list of publications in major journals produced by ESTALLIDOS can be found in annex 3.

PROGRAM 1

Self-consistent modeling of ionized regions.

- A comparative analysis of empirical calibrators for nebular metallicity
  Pérez-Montero, Enrique & Díaz, Angeles I.
  2005, MNRAS, vol 361, pg. 1063-1076
- The temperature and ionization structure of the emitting gas in HII galaxies: implications for the accuracy of abundance determinations
  Hägele, G.F., Pérez-Montero, E; Díaz, A.; Terlevich, E.; Terlevich, R.; 2006, MNRAS, 372, 293
- On the relation between electron temperatures in the O+ and O++ zones in high metallicity HII regions
  Pilyugin, L.S, Vílchez,J.,Thuan, T.X. 2006, MNRAS 370, 737.
- Distribution of extinction and star formation in NGC1569.
  Relaño, M., Lisenfeld, U., Vílchez, J.M., Battaner, E. A&A 452, 413
- Oxygen abundaces in the most oxygen rich spiral galaxies.
  Pilyugin, L. S., Thuan, T. X., & Vílchez, J.M..2006, MNRAS 367, 1139
- An empirical calibration of sulphur abundance in ionized gaseous nebulae.
  Pérez-Montero, E., Díaz, A.I., Vílchez, J.M., & Kehrig, C. 2006, A&A 449, 193

PROGRAM 2

Chemical evolution of galaxies

- The nitrogen-to-oxygen evolution in galaxies: the role of the star formation rate.
  Mollá, M.; Vílchez, J. M.; Gavilán, M.; Díaz, A. I., 2006. MNRAS, 372, 1069
- Low and intermediate mass star yields. II. The evolution of nitrogen abundances
  Gavilán, M., Mollá, M., & Buell, J. F. 2006, A&A, 450, 509
- The impact of the visibility of the [OIII]4363 line on the general properties of HII galaxies in the Local Universe
  Hoyos, C; Díaz, A; 2006, MNRAS, 365, 454
- Low and intermediate mass star yields: The evolution of carbon abundances.
  Gavilán, M., Buell, J. F., & Mollá, M. 2005, A&A, 432, 861
- A grid of chemical evolution models as a tool to interpret spiral and irregular galaxies data.
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- Oxygen and nitrogen abundances in nearby galaxies. Correlations between oxygen abundance and macroscopic properties.
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PROGRAM 3

Galaxy structural parameters

- The stellar host in Blue Compact Dwarf Galaxias: the need for a 2d Fit
  Amorín, R.O., Aguerri, J.A.L., Cairós, L.M. Caon, N., Muñoz-Tuñón,C..2006, Rev.Mex.A.A SC 26, 178
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  Aguerri, J. A. L.; Debattista, Victor P.; Corsini, Enrico Maria, 2003, MNRAS, 338, 465.

- The DEEP2 Galaxy Redshift Survey: Discovery of Luminous, Metall-poor star-forming galaxies at redshifts z 0.7
  Hoyos, C.; Koo, D.C., Phillips, A.C., Willmer, C.N.A., Guhathakurta, P; 2005, ApJ, 635, 21
- Deep Near Infrared Mapping of Young and Old Stars in Blue Compact Dwarf Galaxies
  L.M. Cairos, N. Caon, P. Papaderos, K. Noeske, J.M. Vílchez, B. García Lorenzo, & C. Muñoz-Tuñón , 2003, ApJ, 593, 312
- HST/ACS Lyman alpha imaging of the nearby starburst ESO 338-IG04,
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- Stellar populations in barred spirals
  Cantin, S., Robert, C., Pellerin, A., & Mollá, M. 2006, New Astronomy Review, 49, 536

PROGRAM 4

Massive star formation feedback

- On the Extreme Positive Feedback Star-forming Mode from Massive and Compact Super Star Clusters,
  Tenorio-Tagle, G., Silich, S., Rodríguez-González, A. & Muñoz-Tuñón C. 2005, Astrophysical Journal , vol 628, pg. L13-L16
- On the X-Ray Emission from Massive Star Clusters and Their Evolving Superbubbles
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- Lyman alpha emission in starbursts: implications for galaxies at high redshift,
  J. M. Mas-Hesse, D. Kunth, G. Tenorio-Tagle, C. Leitherer, R.J. Terlevich, E.Terlevich, 2003, Astrophysical Journal, 598, 858
- The first deep ACS Lyman alpha images of local starburst galaxies
  D. Kunth, C. Leitherer, J.M. Mas-Hesse, G. Östlin, A. Petrosian, 2003, Astrophysical Journal, 597, 263
- Supergalactic Winds driven by multiple superstar clusters,
  Tenorio-Tagle,G., Silich,S. and Muñoz-Tuñón, C.: 2003, Astrophysical Journal , 597, 279.
- Young Super Star Clusters in the Starburst of M82: The Catalog,
  Melo, V. P., Muñoz-Tuñón, C., Maíz-Apellániz, J., & Tenorio-Tagle, G., 2005, Astrophysical Journal, vol 619, 270-290

PROGRAM 5

Environmental effects on star formation activity in galaxies

- Active star formation in clusters of Galaxies: extreme starbursts in A634 and A634
  Reverte, D., Vílchez, J.M., Hernández-Fernández, J., Iglesias-Paramo, J, 2006, Astronomical Journal, en prensa
- Structural Parameters of Dwarf Galaxies in the Coma Cluster: On the Origin of dS0 Galaxies
  Aguerri, J. A. L., Iglesias-Páramo, J., Vílchez, J. M., Muñoz-Tuñón, C., & Sánchez-Janssen, R. 2005, Astronomical Journal, vol 130, pg. 475-495
- Ultraviolet emission and star formation in the Stephan Quintet,
  Xu, K., Iglesias-Páramo, J., et al. 2005, Astrophysical Journal, vol 619, pg. L95-L98
- The V-band luminosity function of galaxies in A2151,
  Sánchez-Janssen,R., Iglesias-Páramo, Muñoz-Tuñón, C., Aguerri, J. A. L., J., Vílchez, J. M.,

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- Intracluster stars in the Virgo cluster core
  Aguerri, J.A.L., Gerhard, O.E.; Arnaboldo, M.; Napolitano, N.; Castro-Rodríguez, N.; Freeman, K.C.; 2005, AJ, 129, 2585
- Environmental Effects in the Structural Parameters of Galaxies in the Coma Cluster
  Aguerri, J. A. L., Iglesias-Páramo, J., Vílchez, J. M., Muñoz-Tuñón, C. 2004, Astronomical Journal, 2004, 127, 1344

PROGRAM 6

Star formation under extreme conditions

- Nuclear Activity and Massive Star Formation in the Low-Luminosity Active Galactic Nucleus NGC 4303: Chandra X-Ray Observations,
  E. Jiménez-Bailón, M. Santos-Lleó, J. M. Mas-Hesse, M. Guainazzi, L. Colina, M. Cerviño, R. M. González Delgado, 2003, Astrophysical Journal, 593, 127
- X-ray emission from NGC 1808: more than a complex starburst
  Jiménez-Bailón, E., Santos-Lleó, M., Dahlem, M., Ehle, M., Mas-Hesse, J. M., Guainazzi, M., Heckman, T. M., & Weaver, K. A. 2005, Astronomy and Astrophysics, vol 442, pg. 861-877
- Star Formation in the Nearby Universe: The Ultraviolet and Infrared Points of View,
  Iglesias-Páramo, J., Buat, V., Takeuchi, T. T., et al. 2006, Astrophysical Journal Supplement Series vol 164, pg. 38-51
- The early stage of a cosmic collision? XMM-Newton unveils two obscured AGN in the galaxy pair ESO509-IG066
  Guainazzi, M., Piconcelli, E., Jiménez-Bailón, E., & Matt, G. 2005, Astronomy and Astrophysics, vol 429, pg. L9-L12

OTHER RESULTS

- Organization of 4 ESTALLIDOS Workshops. Electronic publication of the workshops in CDRom and in the project web page: http://www.iac.es/proyect/GEFE/ESTALLIDOS
- PhD Theses: 2 theses defended during 2005 and 2006 (Univ. de la Laguna, Univ. Autónoma de Madrid) and 2 to be presented during 2007.
- Advanced Study Diploma (DEA): 7 DEAs presented: Univ. de la Laguna, Univ. Autónoma de Madrid, Univ. De Granada.
- Members of the ESTALLIDOS team that have obtained post-doctoral positions: Ramón y Cajal: 4; Juan de la Cierva: 3.
- Diffusion of results and vulgarization: conferences in universities, popular universities, science museums, schools, courses for the elderly, etc.
- Participation in summer schools: UIMP, El Escorial (2006)
- Books: “Light with time”, G. Tenorio-Tagle & C.Muñoz-Tuñón, Science for everyone collection: Cultural Economics Fund.
- Participation in the Week for the Science.
- Publication of vulgarization articles in written press and scientific bulletins.

♦ **3.3.** Briefly list, and clearly, precisely and realistically describe the actual goals of the Project (i.e. in agreement with the Project duration). These should conform to the priority themes of the Nacional Program to which the Project is adscribed (see annoucement annex).

The novelty and relevance of the goals, as well as the precision in their definition, is explicitly mentioned among the criteria for evaluation of the research projects (see item # 9 of this call).

Goal 1: Carrying out the ESTALLIDOS Scientific objectives
(Itemized by programs)

- Study the extinction distribution in ionized regions through the use of the 3D MOCASSIN code.
- Study both the nature and properties of the stelar populations in circunnuclear star formation regions (in relation with the star-formation – AGN connection).
- Produce a high quality data base of HII galaxies. Abundance determinations in these galaxies. Design strategies for abundance determinations as a function of redshift.
- Multiwavelength observations (X-ray, UV, Optical & IR) data, together with population syntesis evolutionary models, will be used for studying the stellar populations of the project sample.
- Several star formation rate tracers will be measured and calibrated.
- The actual impact of the star formation modes (instantaneous, continuous, or recurrent) on the BCD galaxies chemical evolution will be established.
- Our results will be compared with those obtained through methods used in other programs, such as hydrodynamical chemical models.
- Study of the impact of the supernova explosion winds on the chemical evolution of galaxies, including the analysis of whether and when this ingredient is necessary.
- Maintain the multi-phase chemical evolution code updated. Include new code as needed.
- Develop a 2-dimensional technique for adjusting structural components in BCD galaxies.
- Develop a 2-dimensional technique for adjusting structural components in barred galaxies. Using this code, determine the structural properties of the bulges of a sample of bright barred galaxies, as well of a sample of dwarf barred galaxies in nearby clusters.
- Study the structural components of a large sample of galaxies in nearby clusters. Compare the results with simulations. Check the possibility of addressing these studies in high-z galaxies using large telescopes.
- Characterize the smallest starburst units in different galaxy types, with a large range of luminosities. Detect tracers of the presence of supergalactic winds in each type of object.
- Check for cases of observational positive feedback of the Star formation.
- Try new theoretical solutions for the interpretation of the mass-metallicity diagram.
- In collaboration with other ESTALLIDOS programs, develop of a key program for large telescopes on the feedback of the massive star formation process . This is part of OBJETIVO 2.
- Parametrization of the effect of the environt on the distribution of $H\alpha$ emission in cluster galaxies. Compare them with field galaxies.
- Application of galaxy evolution models (stellar evolution synthesis coupled with the physics of the gaseous and dust components) to the study of the star formation history of cluster galaxies.
- Determination of the amount, 2D distribution, and kinematics of the difuese light in a sample of nearby clusters. Provide observational constraints on the evolutionary status of these clusters.
- Estimate of the faction of Seyfert galaxies showing violent nuclear star formation.
- Characterization of the circunnuclear starbursts in Seyfert galaxies; comparison with the nuclear starbursts in normal galaxies.
- Study of obscured starbursts and the importance of these in AGNs.

- Characterization of the high-energy emission of Seyfert galaxies and AGNs, benefiting from the new X-ray spectroscopy with XMM-Newton and CHANDRA to study of the physical conditions from X-ray spectra.

Goal 2: ESTALLIDOS with large telescopes:

- Development of simulation to prepare observations with large telescopes (VLT, GTC).
- Development of ad -hoc models for interpreting of the data gathered with special instrumention in these telescopes.
- Work out an ESTALLIDOS Target Catalogue, to be employed in the Consolider- Ingenio program.
- Elaboration of an ESTALLIDOS Key Project.
- Explore the use of other facilities offering complementary wavelength ranges (e.g. GTM).
- Arrange an international ESTALLIDOS based collaboration to prepare our participation in a European network.

Goal 3. Outreach and science popularization

- Publicise from our web site brief reports of the scientific results of ESTALLIDOS.
- Develope monographies on the various topics covered in ESTALLIDOS (one per program).
- Prepare an electronic edition of the complete set of monographies. Explore the possibility of publication in other media of large distribution (e.g. international popularization journal).
- Production of didactic material with topics specific of the collaboration to be used in schools.
- Stimulate and catalogue popularization talks to be given by the members of the team.

♦ 3.4. For Coordinated projects

- The Coordinator should specify:
  - The global objectives of the coordinated project, the necessity for this coordination, and the added value that the coordination will brig to the project.
  - The specific objectives of each subproject.
  - The interaction between the different objectives, activities and subprojects.
  - The foreseen strategy of coodination to secure the success and efficient running of the project.

Following the explanation given in the proposed methodology, this research project will be developed in close collaboration between all researchers participating in the proposal. These researchers are distributed in several research centres. Such a coordinated proposal is, in our view, the most convenient way of putting togheter the expertise and effort of each team, bypassing the idiosyncrasy of each of the participating institutions. Neither a single proposal lead by a single research institution, nor many individual proposals with little relation to one another, would be adequate solutions. For the first option would be prone to administrative difficulties due to the different particularities of the centres, and the second option would suffer from an inefficient dispersion of efforts.

ESTALLIDOS (third phase) proposes to enlarge its goals. It maintains the generic objective of the ESTALLIDOS Science, which has consolidated our team during the past years. This time, however, two new general OBJECTIVES have been added as a result of: (a) the callenge of doing the better and most competitive science in the era of the Large Telescopes, and (b) our commitment for a strong program of science popularization. This commitment is assumed as a *paradigmatic* team, given our science, past trajectory, expertise and cohesion. The coordinator of the project will take up the task of intertwining the three general objectives, and at the same time guaranteeing that a strategy is adopted to complete the specfic objectives of each of the particiaping teams.

The three objectives have the same importance, however they will not require the same dedication from the team members, nor will they be allocated the same amount of resources. The entire ESTALLIDOS team will be involved in both the scientific goals of the project (OBJECTIVE 1) and in the outreach program (OBJECTIVE 3). All team members are initially invited to participate in the preparation of proposals for Large Telescopes (OBJECTIVE 2). The team members will be free to decide their participation in this OBJECTIVE. All three nodes in the collabortation are responsible for carrying out each of the OBJECTIVES.

OBJECTIVE 1: SCIENCE. All team members are active participants.

OBJECTIVE 2: Programs for Large Telescopes. Throughout the duration of the project, several key program science cases will be developed for GTC, ESO, etc. This OBJECTIVE will be our contribution to the CONSOLIDER-INGENIO programs as part of its science group.

Additional tasks will be to participate (and lead) thematic networks, European programs, or programs with Latin America. With this OBJECTIVE we take on the recommendation of the Manager of the National Plan for Astronomy and Astrophysics as well as those of the review team. It is our intention to enlarge and consolidate our international relations in the appropiate framework. This OBJECTIVE 2 is open to those team members willing to contribute to it.

OBJECTIVE 3: Popularization of results. Contribute to live up the enthusiasm of people for science. Two avenues are established here. One devoted to the lay public, the so-called popularization of science, and a second one recently referred to as high-level dissemination of science.

Our efforts for the lay public will be channelled through the Consolider-Ingenio effort. *This will cover our contribution to the Consolider-Ingenio outreach program*. All members of the team are encouraged to actively get involved in this OBJECTIVE. A procedure will be established to ensure that a popular report is done from each publication of the collaboration. Note that the CONSOLIDER-ingenio program will have a specialist giving form to the science news, and procuring the adequate distribution in the media. The high-level dissemination, for professionals, is a continuation of our current activities. We will thus continue using the classical channels, such as books, journals (e.g. Science), electronic publishing, colloquia, seminars, etc. All team members are encouraged to contribute to this OBJECTIVE.

Objective 1. *ESTALLIDOS Science:*

The coordination of the project has been organized, as mentioned in the introduction, and as has been done in the past in ESTALLIDOS 1 and 2, through several programs that are annually reviewed in workshops. Each program has its own objectives and goals that are summarized in what follows. Nonetheless, the ESTALLIDOS project has been conceived as a puzzle, which with the pieces of work of each team member, and the joint analysis of the midterm results, will result in the achievement of our common goal: pinpointing the key parameters that control the formation and evolution of the starbursts.

Program 1: Self-consistent Modeling of ionized regions.

The basic objective of this program is devoted to the realistic modeling of the structure of the ionized gas, and the determination of the stellar population based in the absorption and emission lines, colors, optical and UV continuum, and X-ray emission. The results will be checked against the observations. Likewise, the impact of the models on the determination of the evolution of the physical and chemical parameters will be evaluated. This program can be considered as a "tool" for the rest of the programs. Some of the specific goals of this program are listed below.

- The extinction distribution in ionized regions will be studied using the 3D MOCASSIN code. (Existing data acquired by our team will be used. Additional complementary data will be acquired).
- The properties and nature of the stellar populations in circunnuclear star formation regions will be studied. This problem is intimately related to the so-called *star formation -- nuclear activity* connection.
- A high quality data base will be developed with HII galaxy data. This will be extremely useful for implementing the abundance determination methodology using photoionization models. Schemes for the determination of HII galaxy abundances as a function of redshift will be developed.
- Together with the more recent population syntesis evolutive model, multiwavelength data (X-rays, UV, optical, IR) will be used for studying the stellar populations of the galaxies analyzed in the framework of the project.
- Several tracers indicative of star formation will be measured and calibrated.

Program 2: Chemical Evolution of Galaxies

This program will support the rest of the programs. It is aimed at developing and improving the tools required for an adequate interpretation of the chemical abundances of galaxies undergoing star formation. The specific goals to be undertaken within this program are:

- We will try to establish the actual impact of the star formation modes (instantaneous, continuous, or recurrent) on the BCD galaxies chemical evolution, combining chemical evolution models with evolutive synthesis models as well as with photoionization models. The model predictions will be compared with the estimated chemical abundances as well as with other data relevant to these galaxies.
- Our results will be contrasted with those obtained through methods used in other programs, such as hydro-dynamical chemical models.
- Study of the impact of the supernova explosion winds on the chemical evolution of galaxies. Determine through comparisons with actual data when this ingredient is necessary.
- Maintain the multi-phase chemical evolution code updated. Include new code as needed, as well as new improvements that consider possible advances in this field. There will be a web page with the code and instructions in the ESTALLIDOS site, so that team members benefit from the use of this code.

Program 3: Structural parameters of galaxies and Star Formation

The general objective of this program is the determination of the structural, kinematical, and dynamical characteristics of nearby galaxies, including the galaxy sample of the coordinated project. For Starburst galaxies the relation between the objects morphology-dynamics and star formation will be analyzed. Again, this program is a tool for the other programs.

Specific goals of this program:

- BCD galaxies: development of a 2D technique for fitting the structural components of these galaxies. This will allow us to establish relations between these galaxies and other galaxies of similar luminosity but much lower star formation activity. As part of the program, the CO content and their star formation history will be determined.
- Develop a 2D technique for adjusting structural components in barred galaxies. Using this code, determine the structural properties of the bulges of a sample of bright barred galaxies, as well of a sample of dwarf barred galaxies in nearby clusters.
- Study the structural components of a large sample of galaxies in nearby clusters and check for similarities or differences with field galaxies. In particular, we want to see whether the disks of spiral galaxies in clusters show length scales shorter than those of field galaxies. We also want to compare the results with simulations.

Program 4: Massive Satr Formation Feedback

The main objectives of this program are: (1) to characterize parameterize the smallest starburst *unit* in different galaxy types, covering a broad luminosity range; (2) to detect markers of presence or absence, in each type of object, of supergalactic winds; (3) to find observational cases of star formation positive feedback; (4) to carry out numerical developments incorporating new solutions for the interpretation of the mass-metallicity diagram; and (5) to elaborate a key program for large telescopes on the subject of massive star formation feedback (in collaboration with the rest of the ESTALLIDOS programs).
The specific objectives are detailed in what follows, separated depending on whether they are observational or theoretical.

Observational:

- Detect low intensity ionized structures in *ionized halos* of starburst galaxies. Classify these in bubble/cone categories. Classify objects that are candidates to showing super galactic winds.
- Characterize the population of SSCs in the galaxies available in the HST, to compare the observables with the M82 patron (Melo etal, 2005).
- Determine the star formation history for the identified bursts and structures. (Part of IMD's thesis work.)
- Relationship between the properties of the host galaxy (program 3), bursts, and identified structures. Synergy between the Ph.D. work of IMD and RAB.
- Carry out the IRAM 30m observations and data analysis of BCDs.
- Prepare complementary observing campaigns in X-rays (Chandra) and radio (IRAM & VLBI in collaboration with Dr. P. Planesas, OAN).
- Produce and elaborate new observing proposals: 2D spectroscopy with a FP to study the kinematics (SCORPIO-SAO observations in collaboration with Dr. Moiseev), and study of the physical conditions of the gas in the cores of starbursts already studied by us (PMASS-Calar Alto and FLAMES-VLT observations).

- Use HST visible and IR data (PC & NICMOS) of starburst galaxies to locate superstar clusters.
- Use the Sloan catalogue to study the sample of galaxies candidate to proto-post BCDs. For this we will use luminosity, size and structural parameters from resolved galaxy samples (this program and program 3).
- Detailed multi-frequency comparison with the threoretical results (Programs 1 & 6).

Theoretical:

- Produce more realistic theoretical models using the observational parameters acquired in this program. Relate the cluster parameters with those of the ionized gas structures in order to obtain self-consistent models.
- Search for formal semi-analytical and numerical solutions of the star formation in super-stellar clusters, including the cluster auto-gravity as well as a central BH (related with program 6).
- Analysis of the mass-metallicity relation in galaxies taking into account the bimodal solution for massive and compact clusters (Tenorio-Tagle et al 2005).
- Calibration of new SPH numerical codes (developed by the Juan de la Cierva Fellow who just started in ESTALLIDOS) to the massive starburst problem. Examples will be worked out for comparison with the semi-analytical models produced by our colleagues GTT and SS.
- Porduce outreach material with the results from our team.

Program 5: Study of environmental effects on the star formation rate of galaxies.
In past editions of the ESTALLIDOS, we have carried out a search of active star formation galaxies within a complete sample of nearby clusters. We have now extended this search to clusters in the WINGS data base (web.pd.astro.it/wings) of the Northern Hemisphere, and within the radial velocity interval 5000 km/s < v < 15000 km/s. Likewise, the quantitative morphological analysis of the galaxy sample is providing a methodology for constraining the harassment scenario in galaxy clusters. This edition incorporates a fundamental aspect, such as the analysis of the star formation history from multi-wavelength observation from the UV (2200A) till the Far IR (160 μm). Regarding the study of diffuse light, the Virgo cluster and the nearby groups Leo and HCG44 have been observed. In Virgo, the diffuse light shows a very inhomogeneous distribution, showing a non-relaxed component in the cluster potential, as a result of some mechanisms that have been active until recent times in their evolution. The specific objectives are:

- Publication of the results derived from the $H\alpha$ observations of our complete sample of nearby clusters.
- Morphological study of the gas and stellar emission ($H\alpha$ filters plus continuum) of the galaxies in nearby clusters: implications for the mechanisms regulating the star formation triggering in dense environments.
- Intensive search for galaxies undergoing extraordinary rates of star formation, either because of its intensity or because of its compact morphology. Spectroscopic follow up.
- Multi-wavelength (UV –opticla-IR) study of the star formation history of galaxies in nearby clusters.
- 3D spectroscopy of groups with strong star formation in galaxies in nearby clusters.
- Same as the previous item but for a galaxy cluster sample at intermediate redshift ($0.1 < z < 0.5$).
- Study of the diffuse light for a set of clusters at distances of up to 100 Mpc.

Program 6: Star formation in extreme conditions (relations with AGNs).

- Estimate the fraction of Seyfert galaxies showing violent star formation in their nuclei.
- Characterize the circunnuclear starbursts seen in Seyfert galaxies, sorting these by mass (or start formation rate), evolution status, and luminosity. Compare these starbursts with those in normal galaxies.
- Characterize the properties of the starbursts and their relation with the structural properties of their host galaxies (program 4).
- Study obscured starbursts, and the frequency of these in active nuclei.
- Characterize the high energy emission of starbusts and AGNs trying to distinguish them at high energies. XMM-Newton and Chandra satellites provide X-ray spectroscopy for the first time, thus allowing us to derive the physical conditions of the sources.

These objectives have the final goal of establishing whether there exists relationship between the Seyfert and starburst phenomena, and the frequency with which this relation is observed. For instance: a) Is the BH mass proportional to the mass or to the intensity of the starburst? b) Is the BH accretion rate proportional to the star formation rate of the Starburst? c) Does the starburst evolution follows that of the BH? d) Is the starburst needed for the active nucleus to show up?

COORDINATION ACTIVITIES: (persons in charge: Coordinator + PIs)

Organization of a kick off meeting for revising the three OBJECTIVES of the project:

- Set up calendars with fix term milestones for the various tasks of each preogramme from OBJECTIVE 1.
- Present to the entire team the strategy proposed to achieve the goal of OBJECTIVE 2.
- Set up a joint discussion with the strategies to achieve OBJECTVE 3 (outreach and science dissemination)

OBJECTIVE 1: ESTALLIDOS SCIENCE: (persons in charge: IPs & those listed in section 4)

- Organization of yearly workshops; three workshops, one at each one of the nodes.
- Editing of the results presented in the workshops, revision of the workshops programs. (Responsibles: the workshop organisers together with the Estallidos IPs.)
- There will be a joint meeting of the ESTALLIDOS IPs plus the programs leaders on the occasion of each workshop. These meeting will be devoted to re-assesments of the development of the project, as well as for planning the coordinated actions as proposed in Objectives 2 & 3.

OBJETIVO 2: ESTALLIDOS with large telescopes (persons in charge: new RyC fellows & IPs)

- Call for ideas for GTC & VLT proposals (key programms)
  This will be the first iteration to get a short list with the aim of selecting at most three final proposals. All ESTALLIDOS members will be invited to participate in the selected proposals. Proposal teams definitions. Organization of Kick-off meetings (one per proposal). Each team will define its own working plan.

- Organization of Specifics Key Seminars (SECs)
  These will allow us tackling key topics through special 2 day meetings. They will also permit us to

spot windows of opportunity (topical or ad-hoc, e.g., calls for networks), or to present new numerical simulation codes (e.g. by one of the new JdlC contracts, e.g., a SPH code for supergalactic winds) or a new tool (e.g., an automatic code for the morphological identification of galaxies in large archives).

- Preparatory work: Simulations for the preparation of GTC observational programs

OBJECTIVE 3: Outreach and dissemination of scientific results from the ESTALLIDOS program. (persons in charge: MMH + IPs)

- To establish a protocol for ensuring wide publicity to the *scientific news* originated in the collaboration (persons in charge: JSA, NC, IPs).
- To coordinate the press centers of the institutions involved in the ESTALLIDOS program. All team members take part in this activity.
- Produce a data base for archiving the *estallidos targets* to be provided to the Consolider-Ingenio program.
- Collaborate with the CONSOLIDER-INGENIO 2010 programe in the design of educational materials.
- To produce popularization articles based on ESTALLIDOS research topics (to be stimulated pushed by the leaders of the various programs)
- Preparation of conferences and popular talks. A list of talks will be maintained in the project web page providing free access to the contents. (The leaders of the various programs plus the IPs of the nodes will promote this action).

4.METODOLGY AND WORKING PLANS (including subprojects in the case of coordinated projects)

It must justify and detail the **methodology and the working plans** of the proposed work, including a timeline with the activities and a Gantt chart (this form includes an example of layout).

- The working plans must be divided into activities o tasks, pointing out those milestones you expect to achieve as a result of each one of those activities.
- Each task must be associated with and institution and with the researchers which will carry it out (see Sects. 2.1, 2.2 and 2.3 of this form) . In case that researchers not included in Sect. 2.3 are also involved, mention the scientific merits justifying their participation in the project.
- If the project include new contracts, explain why new personel is require and what are the specific tasks they will carry out.

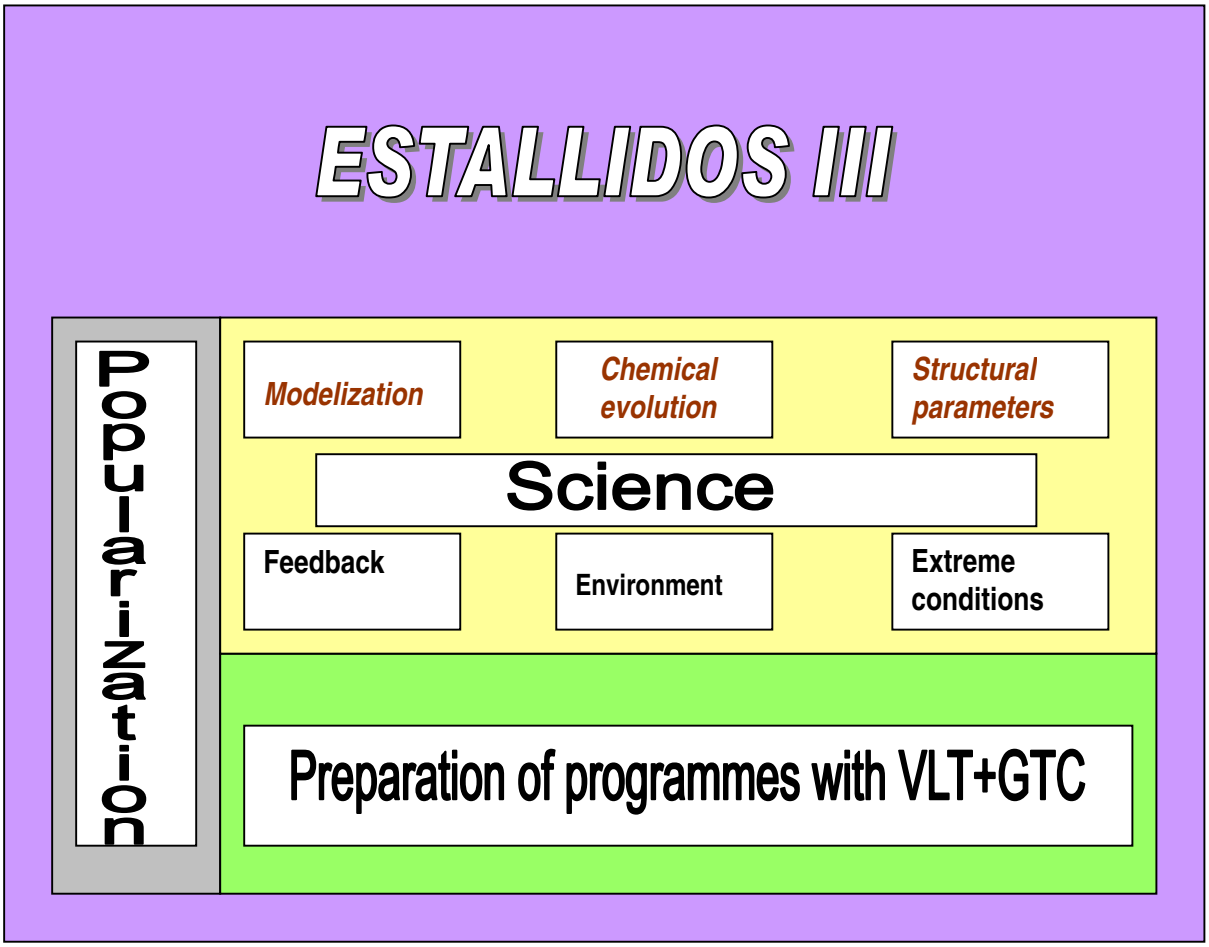
As we pointed out before, the activities included in this proposal can be divided into there main objectives, namely,

- Science of STARBURSTS- ESTALLIDOS.
- Preparing observational programs with large ground based telescopes (VLT + GTC).
- Outreach activities associated with the scientific results of the project .

The FIRST OBJECTIVE is split into 6 specific programs covering all the topics we want to deal with during this phase of the project. The three first ones are mainly theoretical (1, 2 and 3), and they will provide tools to be used by all participants. The table below shows how the different tools to be developed will allow us to characterize the star formation process at different time scales. .

Time scale	**Tool**	**Parameters**
$<10^7$ years	Photoionization models	T, n, Z (emission lines)
10^6 - 10^8 years	Stelar population synthesis models	Synthetic specta, colors, stellar populations
$>10^9$ years	Determination of the structural components	2-D morfology, structural parameters
$>10^7$ years	Chemical evolution models	Gas and stellar content, metallicity of gas and stars

The schematic below shows the relationships between the various parts of the project:



The yellow background indicates those parts of the project embraced within OBJECTIVE 1 (Science). In particular, those programs of theoretical nature to be used as tools for the whole team have a pale yellow stripped background.

The second big OBJECTIVE 2 aims at making use of the large telescopic facilities that are now available to us (VLT) o those to be available soon (GTC). This is an objective whose responsibility is shared by all the sub-teams of the project, first in identifying problems whose solution requires the use of large instrumentation, and then using the experience and strength of a large group to write competitive observation proposals. The plans to coordinate the three big objectives are detailed in Sect. 3.4. This section also spells out how the different participans in ESTALLIDOS are involved in each one of the OBJECTIVES.

The IAC node, which coordinates the project, requests a postdoc position (Postdoc 1) to manage this OBJECTIVE 2. He/she will have to take active part in identifying specific scientific cases of the starburst science for key programs in large telescopes -- together with the coordinator and IP's, the postdoc will have to devolope strategies for a successful use of these unique facilities. He/she will have collaborate in the numerical simulations for designing the observations, as well as in promoting and writing down the observing proposals. The postdoc will also take active part in developing of transnational research

project, some of them within the EU framework. Finnaly, up to 25% of the postdoc time will be devoted to management tasks, as well as tasks to promote the visibility of the collaboration ESTALLIDOS (organization of workshops, updating the web page of the group, with technical information and more basic information suitable for popularizing). The postdoc will not have to start from scratch since the collaboration has a long experience in management.

Finally, all the members of the team will participate in OBJECTIVE 3, i.e., in popularizing the scientific results achieved within the collaboration. All the members are responsible for providing timely, accurate and concise information on their main scientific achivements and, in addition, those members willing to do so will propose and participate in other outreach activities – elaborating didactic materials to be used in schools, presentation of popularization talks, writing of monographs and books for non-scientific readers. All these actions will be coordinated as a whole in order to ensure coherency and visibility.

From this point on, we will describe the methodology and the working plans corresponding to each one of the OBJECTIVES:

OBJECTIVE 1, Science *of ESTALLIDOS*, is divided into six programs.

Program 1: Self consitent modeling of ionized regions.
Persons in charge: Miguel Mas (MMH) & Angeles Díaz (ADB); (CAB & UAM) (Madrid)
Participants: MML, MGV, GTT, JVM, CH, GH, RG, ASB, EPM, MT, DMG, CK, ET

The goals of this programs can be split into to parts: a) study and modeling of ionized gas, and b) study and modeling of ionizing and non-ionizing stellar populations. Consequently, the methodology and the working plans are separted in two parts:

a) Ionized gas:

- Gathering of high-quality data using IFU (integral field units), which provide high spatial and spectral resolutions, simultaneously. Among others, one finds the required instrumentation at the CAHA telescopes (PMAS), WHT (INTEGRAL/SAURON), VLT (FLAMES-GIRAFFE, VIMOS), Gemini (GMOS), and OASIS (CFHT).
- Using the MOCASSIN photoionization models to reproduce the data. This study is aimed at deriving the spatial distribution and the physical conditions of the gas. It would also provide the distribution of ionizing sources, the interstellar extinction, and the geometry. We will be able to investigate issues like the leakage of photons from the ionizing regions to the diffuse gas found in many galaxies, both in the disks and outside (DIG).
- We will try compare the Lyman-α emission in the local Universe and in primordial galaxies, a study based on our experience gathered during the last years, and on the advent of new large telescopes (VLT + GTC). Such instrumentation is mandatory for measuring this emission line at high redshift.

b) *Stellar Populations*:

- We will extend our evolution synthesis models (Cerviño & Mas-Hesse 1994) to X-ray wavelengths. This task requires a new library of X-ray sources associated with star formation regions (massive binaries, supernova remnants), which will be assembled from Chandra and XMM ar-

chive data. The current models used a very primitive representation of this type of sources, and they can be easily upgraded with the data we have available.

- Once the new libraries are included, we will carry out a semi-empirical study of the correlation between X-ray luminosity and the star formation rate. First, the models will be used to calibrate this parameter. Then it will be compared with archive observation of galaxies with star formation..
- Based on this study, we will calibrate the proxies for star formation rate employed in different wavelength ranges. Having such a comprehensive and coherent calibration will allow us to study time variations of the star formation rate in a consistent way.
- All these models and tools will be available to the full ESTALLIDOS team for analyzing the properties of stellar populations employing different observables.

Program 2: Chemical evolution of galaxies
Person in charge: Mercedes Mollá (MML) – CIEMAT (Madrid)
Participants: MMM, JVM, CH, LP, ADB, JIP, EH, CR, JLA, GTT, CMT, CK, BP, RT.

This program is based on using the multi-phase chemical evolution code by Ferrini et al. (1994), which we have employed many times (Mollá et al. 1996,1999, Pilyugin et al. 2000, Mollá et al. 2002) to interpret data from spiral and irregular galaxies, and their halos, disks and bulges. The distributions gas, stars, and chemical abundances obtained with this models agree with the observed galaxies and galaxies and, therefore, the time evolution inferred from the models can be regarded as a realistic representation of the true evolution. In addition, Mollá & Hardy (2002) have checked that combining chemical evolution techniques with evolution synthesis turns out to be a sensitive mean of distinguishing among evolution histories and, thus, this comparison is regarded as a very useful tool.

We will describe the tasks to be carried out within the program considering the two main goals. On the one hand, those related to the scientific study of low mass galaxies. On the other hand, those required to develop of a tool used by the rest of the programs.

Low mass galaxies.
These galaxies tend to be metal poor, which is traditionally interpreted assuming that they undergo a first star formation burst. Accordingly, the data are understood assigning a single age to the burst. In order to fit in these ideas with the low gas content characteristic of the galaxies, one has to assume the existence of intense galactic winds responsible for the mass loss. However, we know that this scenario is incomplete since the galaxies also contain an evolved underlying stellar population at least a few hundred million years old. (This result is partly due to works carried out by our team.) Moreover, the existence of large dark matter halos implies that the presence of galactic winds is not always obvious. We will try to explore which one among the existing scenarios is really consistent with best current observations of dwarf galaxies. Specifically, the tasks to be carried out are:

- ✓ Explore the star formation history of BCD and HII, which are currently undergoing intense star formation episodes localized in small regions. We will analyze whether the star formation was produce as a single burst or in recurrent episodes, and we will try to assign ages and intensities to the bursts. Our preliminary results indicate that each burst has an efficiency between 10-30% (Martín-Manjón et al. 2006). The analysis is based on modeling, which will be improved to include varying initial mass functions, total mass of the cluster, time lag between bursts, etc. The change of these parameters may influence the conclusions. The study is part of the ongoing PhD work of M. Martín-Manjón, which will

be completed during this phase of the project. The work resorts to chemical evolution models, evolution synthesis models, and photoionization codes, which provide a comprehensive view of the galaxy evolution to be compared with the observables.

- ✓ Analysis and classification of low mass galaxies depending on the need for galactic winds, and based on models of chemical, spectroscopic, and photometric evolution. The study is part of the PhD work of M. Gavilán Bouzas. Staring from chemical evolution models, use a evolution synthesis code to compute the magnitudes, surface brightness and colors of the model galaxies. By comparing these theoretical parameters with actual data from all types of dwarf galaxies (dE, dS, dIrr, BCD, and HII), we will: a) find out which star formation histories are consistent with each morphological type; b) determine when galactic winds are/are not required; and c) study whether the observed behavior depends on the mass, environment and morphological type of the galaxy. We are now computing the color vs magnitude diagrams to be compared, directly, with the dwarf galaxies of the local group.

As part of the ESTALLIDOS 2 objectives on chemical evolution of spiral, irregular and dwarf galaxies, we have computed a set of new models (Mollá & Díaz, 2005), which are now publicly available on the web (http://wwwae.ciemat.es/~mercedes). These models result from upgrading the code, in particular, the stellar *yields* corresponding to the production chemical elements in low and intermediate mass stars (Gavilán et al. 2005, 2006). These stars are critical since they supply nitrogen and, therefore, they have to be properly accounted for to understand and interpret nitrogen abundances (Mollá et al. 2006). We are now ready to fully exploit these series of new models.

Relationship of the N/O ratio with the star formation history. Mollá et al. (2006) demonstrate that the N/O ratio depends, critically, on the star formation history of the galaxy or region. If star formation takes place in low yield and spread over a long period of time, then the ratio does not depend on the oxygen abundance (O/H). However, it the star formation occurs in efficient discrete bursts, then N/O shows a secondary behaviour easy to distinguish from the previous case. We would like to explore whether this result allows us to determine the full star formation history and the chemical evolution of a galaxy (so far, it has been used to determine the present star formation rate). The work will follow the guidelines of others carried out within ESTALLIDOS2 (Pilyugin et al. 2004).

Spectro-photometric models for spiral and irregular galaxies. We will synthesize the photometric and spectroscopic properties of the models mentioned above. As a result, we will obtain the radial distribution of colors, magnitudes, surface brightness, and absorption indexes characteristic of spiral and irregular galaxies in the field. The synthetic properties account for the passive evolution of the galactic content, and the chemical enrichment of the medium, and these two ingredients are predicted by our calibrated models of chemical evolution.

Application of the chemical evolution models to high redshift galaxies. We will explore the potential of this set of models, which provide a complete time evolution of the galactic properties. In particular, we will compare their results with high redshift galaxies in the SDSS database, as well as in other large surveys publicly available.

Comparison of the models with bar galaxies. This set of chemical, spectroscopic and photometric models represent an extraordinary tool to support a number of programs within this project,

in particular, for the comparison of structures in bar galaxies describe in program 3. The models refer to normal galaxies. The differences between the predictions of the models and the observed bar galaxies can be attributed to the bar, therefore, such comparison provides a potentially powerful diagnostic tool. The models are also useful for interpreting the spectral indexes of this kind of galaxies observed with the new large telescopes. The work will be carried out in collaboration with program 3, and it is suitable for the thesis project of the PhD student requested within ESTALLIDOS 3.

The effect of the environment in galaxy evolution, , will also benefit from the comparison of observed galaxies in clusters with model predictions. The later represents the behaviour of isolated galaxies. The comparison will be carried out in collaboration with program 5.

In addition to the plans described above, we will set up a web page to be used by the ESTALLIDOS team to compute any other model that may be necessary for specific data analyses. The web page will contain all the information on the chemical evolution code, in particular, a manual to run it. We plan to write a monograph and/or review paper on chemical evolution of galaxies, to be used by the members of the team using the models. This monograph may also be used as a staring point in popularizing talks.

Program 3: Structural parameters of galaxies
Person in change: Alfonso L. Aguerri (JLA) – Instituto de Astrofísica de Canarias.
Participants: RAB, RSJ, MML, CR, CMT, EduT, LCB, AVP, EC, NC, AM, MGV, YE.

Determining structural parameters in galaxies is an important step prior to carrying out dynamical studies of these objects. Moreover, their knowledge allows to classify galaxies and to determine the formation process of the different galactic components. Therefore, as it is already mentioned in the introduction, the new tools to be developed will be extremely useful to all the other programs of this project. Our group has a long experience in this kind of studies. In the previous phase ESTALLIDOS2 we developed an algorithm to carry out the two-dimensional bulge-disk decompositions, which we intend to apply in a sample of galaxies with and without star formation.

Blue Compact Dwarf galaxies (BCDs) show a high star formation rate, spread out over most of the observed galaxy. However, they also show an underlying old stellar host, whose structure and dynamics are still poorly undestood. Since the galaxy energy required to eject the metals depend on whether it is a disk-like or spheroidal object (Silich & Tenorio-Tagle, 2001), determining the structure of this old component is a key issue to tunderstand the role of star formation feedback on the star formation history of these galaxies.

We intend to develop a two-dimensional fitting technique for the old stellar component to be applied to a sample of nearby BCDs. Such technique will be based on an accurate estimate of the star forming region, to be masked out for fitting the underlying component. In order to do so, we will use deep optical, near infrared, and narrow band images, which will give us the shape and size of the star forming region. Before fitting the structural parameters of real galaxies, we will perform the fitting over a set of simulated galaxies with the same characteristics of the real ones. Thus, the simulations will allow us to determine the reliability and the parameter uncertainties involved in the fitting technique.

In addition to the structural parameters of the sample of BCGs we aim to study their kinematics by 3D spectroscopy. In the last years, wider fields of view have been achived by instruments like PMASS.

Many of the galaxies in our sample are included in the PMASS field of view, and thus we can obtain two-dimensional spectroscopic information of a whole galaxy by only a single pointing. We aim to measure the gas fluxes and the rotation of the old stellar component, if any. In addition to the structural parameters we will be able to determine the mass of the galaxies and to do comparisons with other galaxies with the same luminosity but without such an intense star formation. This should be studied by means of the following relationships: Tully-Fisher, Fundamental Plane, and luminosity vs. central surface brightness, effective radii, and Sérsic index of the galaxy old stellar components.

In our previous project we studied the structural components of a sample of spiral and dwarf galaxies in the Coma cluster. We obtained that their structural parameters showed evidence supporting a different evolution from those of similar field galaxies. Specifically, we obtained that the scale length of the spiral galaxy disks in the Coma cluster were smaller than those for similar field galaxies.The interpretation of this result was that some part of the galaxy disks material had been pulled away as a consequence of faster interactions between galaxies or the cluster potential. In the last ESTALLIDOS 2 we developed a new two-dimensional code, devoted to carry out bulge-disk decompositions in galaxies without high star formation. We intend to use this code in ESTALLIDOS 3 in order to fit the structural components of a large sample of nearby cluster galaxies. We have carried out a collaborative work with the WINGS project. They have deep photometric observations of 70 galaxy clusters which are ideal to carry out our work. That study will give us the structural parameters of the bulge and disk components for a sample of ~10000 cluster galaxies. This way, we will be able to determine the differences between cluster galaxies and similar field galaxies parameters, which will give us important observational constraints about the evolutive process in cluster galaxies. This will be carried out in coordination with program 5 of this project.

Spiral galaxies usually show more than two components (bulge and disk). Often, they show elliptical structures called bars, located over the disks. Those barred structures are related with the angular momentum transfer in the galaxy. Bars produce gas flows towards the center of galaxies which can develop starbursts or central black holes. Numerical simulations of barred galaxies show that the bars are related with the bulge formation in galaxies. Since a part of the disk stars are removed from the galactic plane by the bar, they form a thick structure showing similar characteristics with bulges in their mass density profiles. Thus, bulges show surface brightness profiles cuasi-exponential and a high correlation between the bulge effective radii and the scale length of the disk. The add-on of bars in the determination of the structural parameters of galaxies complicates the fits and is rarely done. Several years ago we developed a one-dimensional code for fitting surface brightness profiles specially designed for barred galaxies, which now we propose to improve for two-dimensional fits. These two-dimensional fits will allow us to obtain structural parameters of the bulge, disk, and bar components, for a sample of brighter nearby barred galaxies. Specifically, we want to understand the influence of the bar in the bulge formation. For doing that, we will compare the structural parameters of barred galaxies to those of non-barred galaxies. Their position in the Fundamental Plane will be possible through the central velocity dispersion of the bulges, available in the literature and/or by our own observations. This will give us information of their origin. Spectroscopic observations across the bar will allow us to determine the stellar populations in the bar region by using the developed tools in program 2.

Cosmological simulations about galaxy cluster formation in CMD scenarios show galaxies suffering important morphological transformations along their evolution. Those transformations convert late-type galaxies with star formation in early-type galaxies. The mechanism responsible for that is the expulsion of galatic material (gas and stars) during the infall process of the galaxies into the cluster potential. In some cases the galactic material pulled away can be an important mass fraction of the object, trans-

forming bright galaxies into dwarf ones. These would be non-primordial dwarf galaxies. To estimate the efficiency of that mechanism in the dwarfs formation would be an important observational constraint to the cosmological models, since the origin of the dwarf galaxies is a cornerstone in galaxy formation models. Simulations also show dwarf galaxies developing temporary bar structures. We aim to study the photometric parameters and the dynamics of a sample of barred galaxies in nearby clusters of galaxies. The bar dynamics will be studied by the velocity pattern estimation. This will be carried out by the Tremaine-Weimberg method, which we already applied to study the velocity patterns of brighter barred galaxies during ESTALLIDOS 1 and ESTALLIDOS 2 (Aguerri et al 2003; Corsini et al. 2004). Whether the velocity patterns are faster or not, will allow us to estimate their origin. Moreover, combination of photometric and kinematic data will allow us to study the Tully-Fisher relashionship and the Fundamental Plane of this galaxies, which will give us observationally constraints of their origin.

Program 4: Feedback in massive star formation
Persons in charge: Casiana Muñoz-Tuñón (CMT) & Guillermo Tenorio-Tagle (GTT); IAC & INAOE
Collaborators: JSA, JVM, IMD, SS, EduT, AM, LCB, MML

The working hypothesis, resulting from the research we have carried out in the last ten years, is that massive star formation can be understood as the superposition of star formation taking place inside some fundamental units called superstar clusters (SSC). SSCs vary significantly in mass, from a few times 10^3 M_{sun} up to 10^6 M_{sun} (Ho et al. 1999). The density and luminosity function of the population of SSCs present in a galaxy nucleus are the parameters that we have identified as indicators of the 'ability of a massive starburst to develop a Supergalactic Wind' (Melo et al. 2005). These winds consist of processed gaseous material being ejected from the galaxy, that adopts an approximately filamentary structure, as seen in M82. Our theoretical work has shown that in order to reproduce the geometry of supergalactic winds, an efficient self-collimation of the energy and matter ejected by the SSC units is needed.

We also know that some solutions to the evolution of SSCs favour the continuation of the star formation process: the so-called positive feedback. The opposite case, i.e. negative feedback, would correspond to the case of the generation of supergalactic winds.

The coeval formation of a stellar cluster, massive and compact, and the continuous random deposition of mass and energy through the winds and supernova explosions (SN) taking place within, generate a strong overpressure that results from the efficient thermalization, through multiple collisions, of the wind/SN's kinetic energy. The adiabatic solution of Chevalier & Clegg (1985) (see also more recent calculations by Cantó et al. 2000; Raga et al. 2001 and Rockefeller et al. 2004, 2005), shows that the overpressure generates a very uniform density and temperature distribution inside the SSC. Nevertheless, there exists a pressure gradient large enough to make the gas velocity grow from zero in the centre to the sound speed a_s at the cluster edge ($r = R_{SC}$). The hot gas then flows to the outside producing a steady wind in which the mass injection rate equals the amount of mass per unit time that is leaving the cluster; the density (ρ_w), temperature (T_w) and pressure (P_w) quickly reach their asymptotic values ($\rho_w \propto r^{-2}$, $T_w \propto r^{-4/3}$ and $P_w \propto r^{-10/3}$) whereas the wind speed approaches its terminal value, $2a_s$.

More recently we have shown that the winds driven by compact and massive clusters, instead of behaving adiabatically, become strongly radiative (see Silich et al. 2003, 2004). The inclusion of radiative cooling does not affect substantially the density and velocity distributions. The temperature distribution,

however, does change importantly: it suffers a big drop to $T \cong 10^4$ K near the cluster edge. As a result, the typical size of the regions of X-ray emission predicted by the adiabatic calculations is drastically reduced.

In addition, we have found that in the plane $L_{SC} - R_{SC}$ there is a limiting line above which radiative cooling becomes catastrophic in the cluster interior and hence the development of a steady wind is inhibited (Silich et al. 2004). Two solutions to this situation have been proposed (Tenorio-Tagle et al. 2005a, b). Both start from the fact that the gas will not be able to escape the cluster and thus it will accumulate inside. The first solution assumes that photoionization keeps the temperature at $T \cong 10^4$ K, and in the absence of gravity, the build-up of gas inside the cluster will continue until an isothermal winds develops. Although the wind speed in this solution is high (a few times the sound speed c_{HII}), it is lower than the escape velocity from massive and compact clusters ($v_{esc} = (2\ G\ M_{SC} / R_{SC})^{0.5}$). Likewise, the physically correct solution for clusters above the aforementioned limiting line (see Fig. 1 of Tenorio-Tagle et al. 2005b and Tenorio-Tagle et al. 2006) becomes apparent when the accumulation of material is compensated by gravitational instabilities, so that it becomes steady as new generations of stars are formed. This causes a positive feedback in the star formation process whereby the accumulated material is transformed into new stars.

The exact position of the limiting line in the L_{SC} vs R_{SC} diagram depends strongly on the metallicity of the material emitted by winds and SNs (Tenorio-Tagle et al. 2005b), as this affects the cooling rate. It also depends on the heating efficiency (Silich et al. 2006) or on the amount of energy that after complete thermalization has not been immediately radiated, as is the case with very close sources; that is the reason why one can assume that it is deposited uniformly within the cluster and causes an (isotropic) overpressure (Stevens & Hartwell 2003, Melioli & De Gouveia Del Pino 2004).

From what we have said before, it becomes apparent the importance of constraining the model parameters to understand the problem of star formation feedback. We propose to tackle this problem following the most appropriate strategies required by each of the proposed goals (observational and theoretical) comprising this program:

<u>To accomplish our (observational) goals (see breakdown in Section 3.4) we analyze:</u>

- ✓ Observations of 3D spectroscopy, Fabry Perot, and PMASS, OASIS and FLAMES. The spectral resolution of the FP will allow us detailed kinematical analysis both of the gas in the starburst knots and the out-burst gas. The spectral range of the PMASS/OASIS/FLAMES observations will provide a detailed description of the heart of the starburst (SSCs and surrounding gas). (Collaboration with program 1.)
- ✓ Deep multiband and narrow-filter images for the detection and detailed characterization of clusters and diffuse gas in the sampled galaxies (30 BCDs of different morphological types: compact, cometary, multiknots, nucleated). Detection and characterization of low surface brightness structures and their relation with massive starbursts.
- ✓ Analysis of the observations of the HST archive (already compiled) appropriate for our study (starbursts that can be analysed with the required resolution, i.e., a few parsecs, which is the typical size of a SSC).
- ✓ Elaboration of catalogues of archived SSCs that have already been measured in order to define the distribution of sizes, luminosities and masses.
- ✓ Extract general conclusions that may be extrapolated to unresolved objects.

- ✓ Complementary mass measurements through FP observations – e.g. velocity dispersions, in coinciding samples. Comparison and discussion of the results (in a research in progress we are finding incompatible results that might lead to novel conclusions regarding the 'hidden mass' in massive star clusters or regarding the non-applicability of sigma-measurements for mass determinations – traditionally used to derive masses of high redshift objects).
- ✓ Observations of CO and HI of a subsample of BCDs. Selfconsistent model of the subsample (in collaboration with programs 1, 2 and 3).

We will also do:

- A self consistent hydrodynamical modeling of the galaxies using the photometric and kinematic information available as well as the information on the underlying galaxy (obtained in program 1). We will work on the history and outcome of the star formation process seeking the hydrodynamical models that fit burst ages and low surface brightness structures to modelled galaxies (in collaboration with programs 2 and 3). Besides, we will check the consistency with the chemical evolution models that fit the observables.
- Seek the model parameters to include them in the mass-metallicity diagram.
- We will define the 'type of dwarfs' that is likely to develop SSWs. Parameterize to identify new targets (galaxies), that allow us to build a new list of candidates to be observed with GTC (Osiris).
- Sloan analysis of post-starburst galaxies. Searching for the 'quiet' population. What is left after the BCD stage? We will search in SLOAN for objects with similar parameters to those established for the underlying galaxy of the analyzed sample of BCDs. The primordial BCDs (compact and less luminous) are different (from the structural standpoint as well as regarding the nuclear starburst properties). Use models to seek selfconsistent solutions.
- Write new observing proposals to observe the content and kinematics of the ionized gas and the cold phase (HI and H2), the ionizing clusters and the underlying population (optical and IR broadband photometry).

<u>To accomplish our theoretical goals (see breakdown in Section 3.4) we propose to undertake the following works</u>:

Recent hydrodynamical calculations in 1D and 2D, taking also into account radiative cooling, have allow us to confirm the position of the limiting line in the L_{SC} vs R_{SC} diagram. With these tools we have also doubled-checked the steady solutions for clusters below the limiting line, whereas for massive and compact clusters, above the limiting line, we have found a bimodal solution (Tenorio-Tagle et al. 2006). In these clusters the central (denser) zones are those which cool down catastrophically, causing the accumulation of matter and the formation of stars. On the other hand, the material injected in the outside regions of the cluster is able to balance the loss of energy through radiation emission with the rate of deposited energy; in this way, a steady wind, heavily radiative, can be generated.

The semi-analytic solutions to these problems need to take into consideration that catastrophic cooling in the central zones drains a large fraction of the energy as soon as this is deposited. This leads to the loss of pressure and the flattening of the radial pressure gradient, which in turns inhibits the development of a steady wind, thus fostering the accumulation of matter inside the cluster. Formally this implies the displacement of the stagnation point toward the outside. This allows us to re-write the conservation equations and find semi-analytical solutions. The bimodal behaviour displayed by massive compact clusters can then be univocally characterized. Our results indicate that the fraction of injected matter

that the clusters reintegrate into the interstellar medium decreces monotonically with the cluster mass. The rest of the mass accumulates, increases its density and favours a more effective cooling. Finally, the accumulation process becomes steady when the accumulation rate equals the star formation rate.

The immediate impact of these results can be appreciated when we compare with evolution synthesis models (results from program 1). We predict that massive compact clusters inject into the interstellar medium an amount of mass smaller than that predicted by extrapolations of the standard stellar evolution models. It is also worth noting that the UV radiation flux is also reduced since the accumulated material absorbs an important part of it.

We plan to tackle the following theoretical problems.

- Formal quasi-analytical and numerical solution, including selfgravity of the cluster as well as that of a point source (black hole).
- Impact of a high-pressure medium on steady winds.
- Bimodal solution in events of continued star formation.
- Detailed multifrequence comparison with the theoretical results.
- Analysis of the relation mass vs metallicity in galaxies, taking into account the bimodal solution for massive compact clusters.
- Explore the use of 3D SPH techniques for this type of problems (SPH code already available through the new member of the collaboration and Juan de la Cierva fellow Eduardo Delgado Donate).

Program 5: The effects of the environment on the star formation activity
Persons in charge: Pepe Vilchez (JVM) & Jorge Iglesias (JIP); (IAA) (Granada)
Participants: JHF, DRP, RSJ, JLA, CMT, NC, MML, LMM, BC

The study of the influence of the environment on the evolution of cluster galaxies will be carried out following the adequate strategy for each of the goals in the program:

- The star formation rate (SFR) will be studied using our Hα images of nearby galaxy clusters. It is known that the Hα luminosity of a galaxy is a good tracer of its content of young stars, and thus of its present SFR. The presence of close companions or of a dense intergalactic medium can generate interactions leading to both an increase -if molecular clouds are compressed- or a decrease –if the outer gas disk is swept- of the SFR. In these cases, the intensity and the Hα morphology of the galaxy will be good indicators of the kind of process that regulates its SFR. At the moment, we are constructing a catalogue with luminosities and morphology-related parameters (asymmetry and concentration) of the Hα emission from our nearby Universe database. The comparison between the Hα luminosities with those of field galaxies (i.e., not residing within clusters) will provide information on the global effect of the environment on the SFR of a galaxy. Moreover, Hα emission morphology-related parameters, together with the galaxy position within the cluster, will be compared with the prediction of models of galaxy evolution in different environments, in order to investigate processes that dominate and regulate the SFR of cluster galaxies.

- Another interesting aspect related to the SFR of cluster galaxies is the search of new BCD galaxies with intense Hα emission. A deep and detailed search in the database is needed in order to carry out this goal. The presence of this type of galaxy in clusters is important for several reasons; first, the global contribution of this kind of objects to the cluster total SFR remains unknown, mainly because their very low optical and IR luminosities have prevented them to be included in most catalogues of cluster galaxies in these wavelengths. However, they are easily detected in Hα images. Furthermore, their only existence in galaxy clusters, where the environment is much more extreme than in lower density regions, is a challenge for theories trying to explain their origin and subsequent evolution within the cluster. Therefore, a complete census of this kind of objects seems mandatory, which will be later complemented with a spectroscopic follow-up aimed at precisely determining their physical properties, origin and evolution.

- In order to precisely determine the star formation history (SFH) of cluster galaxies, a multiwavelength imaging database is needed. While the Hα emission line is a good tracer of the instantaneous SFR, the complete star formation history of a galaxy requires the knowledge of its fluxes at different wavelengths, covering if possible from the UV ($\lambda \sim 2000$ Å) to the FIR ($\lambda \sim 100$ μm). The reason for this is that properties of the different components of galaxies are derived from the fluxes in different spectral regions. While stars emit most of their light in the UV, optical and NIR, the interstellar dust mainly radiates in the FIR. These two components are closely related one to each other, and the combination of both is necessary for determining the SFH of a galaxy from its formation until today. Thus, in order to achieve our goals we selected a sample of nearby cluster galaxies with available multifrequency data from both ground and space observatories. Once the database with the fluxes of the galaxies in the sample is built, we will determine their SFH through the comparison of these values with a set of galaxy models generated with several galaxy evolution codes (available to us through the membership of J. Iglesias to the MAGPOP network). Once the sample's SFH is determined, we will look for correlations between these SFHs and global (such as mass and evolutionary status of the cluster) or local parameters (position within the cluster, presence or absence of close companions) of the clusters in order to determine which physical processes have shaped these SFHs.

- Galaxy interactions with other galaxies and/or with the cluster gravitational potential, as well as the processes that lead to the formation of the halos of bright and massive galaxies within clusters, result in the formation of the so-called 'diffuse light' -intracluster material that was stripped from their host galaxies. This cluster component has a B-band surface brightness fainter than 28 mag/arcsec^2, just 1% brighter than the sky background. This faintness renders its detection extremely difficult. Only in the last years several detection techniques have been developed, which mainly consist in the detection of low surface brightness bridges and tidal tails between cluster galaxies, or in the study of an intracluster stellar population. During the previous ESTALLIDOS2 we have studied the diffuse light in the Virgo cluster and in two nearby galaxy groups (Leo and HCG 44). Our results indicate that this diffuse light presents a very inhomogeneous distribution in Virgo, a clear evidence suggesting that this component is not relaxed within the cluster potential and that the responsible mechanisms must have been active in the cluster until recent epochs. Moreover, the diffuse light in Virgo is mainly located in the central region of the cluster, indicating that its origin is related to the formation of the large halos of the brightest galaxies in Virgo. This diffuse light contributes up to 10% of the total light in the cluster (Aguerri et al. 2005). In the studied galaxy groups no diffuse light was detected, an indication of these groups still being dynamically young and in the process of assembly (Aguerri et al. 2006).

This result is in agreement with numerical simulations that establish that the amount of diffuse light in high-density environments depends on the system mass.

- The detection of this intracluster component has been carried out through the direct observation of planetary nebulae (PN) in different intracluster and intragroup regions. Their detection was possible with deep broad- and narrow-band photometric observations containing the [OIII] 5007 A at the distance of Virgo and the studied groups. The photometric detection technique was developed by Jacoby (1989) in order to study the PN population in Virgo elliptical galaxies. According to this technique, all sources detected in the narrow filter (including the [OIII] line) and not in the broad-band filter are considered PNs. This photometric technique allows us to detect PNs at a maximum distance of ~25 Mpc, given that further than this distance too long exposures are needed. In this new project we aim at studying the diffuse light in a sample of clusters at distances up to ~100 Mpc. This study will be made through the use of spectroscopic techniques in 10m-class telescopes (e.g. GTC). Thus, blind spectroscopic surveys will allow the detection of emission line objects in a given field. The detection of the [OIII] doublet will allow the identification of PNs at the cluster distance, as well as the determination of the object line-of-sight velocity and thus trace the kinematical characteristics of the diffuse light. We want to study a sample of 10 clusters with different physical properties and measure the amount, distribution and kinematics of their diffuse light component. This will provide important observational constraints on the evolutionary status of the clusters.

Program 6: Star forming activity in extreme conditions
Persons in charge: Miguel Mas Hesse (MMH) & María Santos (MSL); (CAB & XMM) (Madrid)
Participants: EJ, ALL, NL, PR, CRA, JMR, ADB, RT, GH

We describe the different scientific contributions to be expected within this program. In some cases the confirmation of observing time already solicited is still pending. Although it is not realistic to think that all the requested observing proposals will be granted, we do expect that at least part of them will be accepted. During 2007, we plan to begin with the analysis of the granted observations as we continue with our current projects. We will also work in the rejected proposals in order to improve them taking into account the comments of the evaluation comities and our own new scientific results. These proposals will be resubmitted in the following observing campaigns. The participants of ESTALLIDOS contribute, significantly, to all the working lines described below, but they will also be carried out in collaboration with other scientists not included in the project.

<u>Characterization of the X-ray spectrum of AGN:</u>

- Characterization of the AGN population: fraction of obscured/unobscured AGN. X-ray observations of a sample of INTEGRAL AGN: an XMM-Newton observing proposal has been submitted to study below 10 keV a sample of 37 AGN detected by INTEGRAL. Our main goal is to determine the fraction of obscured/unobscured AGN and to explore the absorption in the type 1 AGN. As all the targets have been selected from observations in wavelengths not affected by absorption, the sample is unbiased and therefore quite suitable for this project.

- Relationship between the AGN and their environments: AGN embedded in galaxy clusters: E1821+643: our analysis of XMM-Newton data has shown that the X-ray spectrum is mainly dominated by the AGN. Nonetheless, a contribution of an ionized iron emission line, probably

related to the hot cluster gas is also present in the spectrum. On the other hand, a Chandra data analysis, performed by other authors, suggests the presence of high velocity wind originated in the vicinity of the nucleus. The short XMM-Newton exposure is also compatible with this scenario. However, if this is the case, the physical conditions of the wind would have changed from one observation (Chandra) to the other (XMM-Newton). It is mandatory to discern between the two possibilities: are the spectra of some AGN contaminated by the emission of hot intergalactic gas of the cluster, or are the spectra showing relativistic absorption features imprinted by high velocity winds in the vicinity of the accretion disk?

- Radio loud AGN: 3C 382 and Mrk 668. The former is a very bright radio galaxy with broad emission lines while the later is also a bright radio galaxy with a very compact and symmetric radio structure. The X-ray spectrum of 3C 382 shows clear evidences for complex absorption due to a wind as well as a relativistic Fe emission line. Regarding Mrk 668, the aim is to study the relationship between the accretion disk and the radio jet by analysing radio and X-ray light curves.

- Soft X-ray excess: which is its origin? Is it related to the high velocity winds or to the nuclear continuum reflected by the disk? We aim to answer these questions by studying the high resolution X-ray spectra and the ultraviolet (UV), soft and hard X-ray variability. XMM-Newton has the capability of providing simultaneously all the observing data. We have selected the Narrow Line Seyfert 1 galaxy Mrk 1044 because of its huge soft X-ray excess, its highly variable X-ray and UV emission, and its large brightness. All these properties make Mrk1044 an ideal laboratory to perform this study with a standard XMM-Newton exposure.

- Characterization of spectral properties of Seyfert 1 galaxies in soft X-rays. This is one of our current projects in which we are analysing both proprietary and archival XMM-Newton data. We are taking advantage of the unprecedented XMM-Newton spectral resolution in the soft X-ray band in order to unambiguously establish the general properties of these objects in the this energy band. Our preliminary results show that the existence of absorbing material, probably due to high velocity winds, is no a common feature in Seyfert 1 galaxies. However, we do find emission lines of highly ionized elements in combination with a power law continuum, the later not detected in Seyfert 2 galaxies.

- Characterization of the type 1 AGN X-ray spectrum using high signal-to-noise data of a complete sample. This project is pending of approval of all the objects in the sample, since a complete sample analysis is essential for the goal of the project. The observing proposal has been submitted in October 2006.

<u>Starburst– AGN connexion in the high energy range:</u>

- Study of galaxy pairs and search for pairs of AGN or starburst-AGN pairs in X-rays. This is also one of our ongoing projects, and the first results of XMM-Newton observation campaign are about to be submitted for publication. At the moment, we are also working on the analysis of complementary Chandra data and recently we have requested a second stage of XMM-Newton data. As the extinction effects are less important in the X-ray band, this type of studies is suitable to discover hidden AGN. The main goal of the project is to verify if the quiescent Black Holes (BH) are activated by galaxy interaction. As a matter of fact, merging systems tend to trigger starforming processes in the nuclear regions, converting them in ideal laboratories to study the starburst-AGN connexion.

- Study of the X-ray emission in Seyfert 2 galaxies with circumnuclear starburst activity. This is also one of our current projects. The observational campaign has been partially approved although not already performed, and another proposal has been submitted in order to complete the original sample. The goal is to characterize the contribution of the starburst emission to the X-ray radiation using population synthesis models. The properties of the starbursts (mass, age, metalicity, extinction) are derived through optical and UV data. In such a way, we are able to disentangle in the X-ray the contribution of the AGN from that of the starbursts.

- Analysis of a representative sample of luminous IR galaxies: the study consists in the observation of the sample with XMM-Newton and will be performed in collaboration with Almudena Alonso Herrero. We aim to characterize the extreme processes taking place in these objects, most likely nuclear and starforming activity. Observations in other wavelengths (UV from GALEX and HST, and IR from HST and Spitzer) were already performed, and our contribution will be to include the X-ray observation analysis, in case the XMM-Newton proposal is granted. Compared with previous studies, our project presents the advantage of being a multiwavelength study. Moreover, the galaxies constitute a representative sample of luminous IR galaxies: they are neither the most luminous objects – which is the case of previous studies – nor the most probable AGN hosts. The X-ray study of these objects will allow us to establish possible relation between the star forming activity (characterized in other wavelengths) and the X-ray emission; determine the parameters of the empirical relationship between the star formation rate and the X-ray luminosity, search for hidden AGNs, and develop emission models for the various components that will be applied to high redshift luminous IR galaxies.

Study of circumnuclear starforming region in galaxies with and without active nucleus: We aim at determining the physical properties of the gas and the stars of the starbursts regions, their masses and evolutionary state. In particular, we aim at determining the kinematics of the gas in these regions. The study could provide important hints on the presence of radial velocities of gas which is feeding the active nucleus. This is an on-going work that will be further developed during this project.

In order to reach the objectives of programs 1 and 6, we find it crucial the contribution of a postdoctoral position in the group at Madrid (Postdoc2). Enough working time will be necessary to perform the great amount to work required by the proposed activities. The postdoctoral fellow will carry out multiwavelength studies in the starburst/AGN connection coordinating his/her work with UAM and ESAC scientists. On the one side, the postdoctoral fellow will take advantage of the knowledge on ionized gas physics and of the evolutionary synthesis models. On the other side, he/she will use our experience on X-ray data analysis. We stress the importance of a post-doctoral contract, regardless of a possible future request of a Juan de la Cierva (JdC) researcher also linked to our project. Our experience shows that taking into account bureaucratic delays, a JdC could only join the project in its second half.

Working plans for OBJECTIVE 2:

We will issue a first call to all the ESTALLIDOS group to discuss scientific cases, join together those that are complementary to one another and merge them into *Key Programs*. We will give some ideas which will be discussed and developed by our team, together with those ideas arising from call.

1. - Elaboration of observational programs for large telescopes. Some possibilities for GTC .

- The study of the SFR in clusters at high redshift is complementary to the first of the proposed objectives (OBJECTIVE 1 - program 6) and devoted to the influence of the environment on the SFR in galaxy clusters. Hα images are good tracers of the SFR. However, it is quite difficult to obtain Hα images of galaxies at intermediate redshifts ($0.1 < z < 0.5$) using 2-4m class telescopes. Thus, this scientific program will be carried out with the GTC and its instrument ELMER. Thanks to this combination of telescope plus instrument, we will be able to obtain a database of Hα images for a representative sample of clusters with redshifts between 0.1 and 0.5, with an image quality good enough to develop a study which parallels the one mentioned in the first section of this chapter. Moreover, from the influence of the environment on the SFR in galaxies at this redshifts, we will be able to assess the existence of an evolution in the cluster total SFR.

- We can also carry out the study of the diffuse light in a number of clusters at distance up to 100 Mpc by means of spectroscopic techniques with 10m class telescopes such as GTC. This way, through deep blind spectroscopic mapping we will detect emission line objects in a given field. The detection of the [OIII] doublet will allow us to determine what objects are planetary nebulae at the distance of the cluster. Furthermore, this technique will permit to determine the velocity along the line of sight and trace the kinematical properties of the diffuse light in clusters. We plan to study a group of 10 clusters with different physical properties to measure the amount, distribution, and kinematics of their diffuse light. This will provide us with meaningful observational constraints on the evolutionary state of the cluster.

- The search for indicators of the presence of Galactic SuperWinds (Imaging with ELMER and/or OSIRIS tunable filters - OBJECTIVE 1, program 4) can certainly be a competitive proposal. We start from the results obtained in our previous work: e.g. density and luminosity of SCCs, and from a preliminary archive of objects selected with HST observations. We also have the whole parameter grid of our models, which will allow us to search for candidates in SLOAN.

2.- Starbursts simulator with Elmer at the GTC. The objectives of this project are:

- Upgrade our evolutionary synthesis code (García Vargas, Mollá & Bressan 1998; García-Vargas, Bressan & Díaz 1995a,b) with the most up-to-date isochrones, atmospheric models for massive stars and stellar libraries, in particular those used to date the star-forming knots for different metallicities (CaT, WR). The code will introduce as a main package the scientific performances of ELMER, with the purpose of building a HII region and starburst spectrum simulator, which will be the basis to interpret the observations with ELMER at the GTC, in the framework of ESTALLIDOS (it embraces programs 1, 4, 5 and 6).

- To establish a new user interface to allow the program to be used through a Web browser.

The key programs of the different GTC instrumentation scientific groups have very different objectives, from cosmological, oriented to studies in wide fields at moderate (OTELO, OSIRIS in the visible) or intermediate (GOYA, EMIR, in the near IR) redshifts, to cold and compact objects like dwarfs and planets (CanariCam in the mid infrared). However, there are fundamental questions about star formation bursts which can not be answered with data from 4-m class telescopes, and have been left out of the GCT Key Projects associated with the instruments. Elmer at GTC is an excellent instrument for many of ESTALLIDOS objectives. Among others, we will be able to carry out detailed studies of high-metallicity, low surface brightness HII regions, stellar populations, gas dynamics and kinematics in nearby starbursts, abundance gradients for the study of chemical evolution, and stellar populations and abundances in dwarf galaxies.

The most effective scientific exploitation of the observed data requires a theoretical basis for their interpretation. A fundamental tool is the combination of evolutionary synthesis and photo-ionization models, which allows to predict both the characteristics of the stellar population and the emission line spectrum of the photo-ionized gas. In the framework of the project ESTALLIDOS 3, and in collaboration between Madrid (M. Mollá) and Canarias (M. García-Vargas), we wish to update our synthesis and photo-ionization code (García Vargas, Mollá & Bressan 1998; García-Vargas, Bressan & Díaz 1995a,b) with the new Padua isochrone models, atmospheres, and observed stellar libraries. In particular we will collaborate with the Padua group to develop the best synthesis models for young populations, including dust (Panuzzo et al 2003 http://web.pd.astro.it/galsynth/) and WR stars, in order to both simulate the ionizing continuum (Smith, Norris and Crowther, 2002, MNRAS 337, 1309), essential to obtain the emission line spectrum of the gas, and to reproduce the bumps in the optical spectrum (Crowther & Hadfield 2006, A&A, 449,711). Finally, we will build spectra with new and complete libraries observed in the optical, such as MILES (Sánchez-Blázquez etal. 2006, A&A, in press). Once we have updated the code with the latest models and libraries, we will proceed to mimic how such populations would be seen by Elmer at the GTC. We well produce spectra as observed with ELMER prisms, grisms and VPHs, taking into account their transmission and spatial resolution as a function of the wavelength. We will also simulate colors in the broad- and narrow-band filters. We will introduce the values of the atmospheric transmission curve at the Observatorio del Roque de los Muchachos, and of the GTC mirror reflection curve. Our first objective is to build these libraries of synthetic spectra, while our final objective is to create a Web-based tool to allow future GTC user to exploit in the most effective way all the scientific potential offered by ELMER.

Working plans for OBJECTIVE 3:

They have been described elsewhere in this booklet; see Sect. 3.4, and also Sect. 5. This objective will be carried out in close collaboration with Consolider-Ingenio.

4.1 GANTT CHART (ONLY APPROXIMATE)

This Gantt chart should account for all the researchers included in the application and, if appropriate, also for the personal to be hired as part of the project. Underline the name of the main responsible for each task.

Activities/Tasks	Institute responsible	Person in charge and others involved	First Year (*)	Second Year (*)	Third Year (*)
OBJECTIVE 1- The Science of ESTALLIDOS Coordination of the Project and organization of the ESTALLIDOS Workshops and Seminars.	IAC	CMT, JVM,ADB,MMH	During the year	During the year	During the year
Elaboration of Telescope proposals	IAC, IAA, MADRID	CMT, JVM, ADB All the Team			
To ensure the fulfilment of objectives of program1	IAC,IAA,Mad	MMH,ADB+ group. Prog1 Postdoc2	During the year	During the year	During the year
To ensure the fulfilment of objectives of program2	IAC,IAA,Mad	MML+group. Prog2	During the year	During the year	During the year
To ensure the fulfilment of objectives of program3	IAC,IAA,Mad	JLA +group. Prog3	During the year	During the year	During the year
To ensure the fulfilment of objectives of program4	IAC,IAA,Mad	GTT, CMT +group. Prog4	During the year	During the year	During the year
To ensure the fulfilment of objectives of program5	IAC,IAA,Mad	JIP, JVM +group. Prog5	During the year	During the year	During the year
To ensure the fulfilment of objectives of program6	IAC,IAA,Mad	MMH, MS+ group Prog6, Postdoc2	During the year	During the year	During the year
Observing Campaigns	IAC, IAA MADRID	CMT, JVM, ADB All the Team	During the year	During the year	During the year
Modelling Developments Synthesis - High Energy Libraries - SF trazers - Comparison with data bases Hydrodynamics .....Chemical Evol. and Pop Synthesis ..... .Structure of galaxies (2D)	 MADRID IAC MADRID IAC	 MMH, EJB, postdoc2 GTT+group. Prog4 MML+ group Prog2 JLA + group. Prog3	During the year	During the year	During the year

(*) Mark the box associated with the corresponding months.

4.1 GANTT CHART (ONLY APPROXIMATE)

This Gantt chart should account for all the researchers included in the application and, if appropriate, also for the personal to be hired as part of the project. Underline the name of the main responsible for each task.

Activities/Tasks	Institute responsible	Person in charge and others involved	First Year (*)	Second Year (*)	Third Year (*)
OBJECTIVE 2- ESTALLIDOS: research with large telescopes					
Call for proposals for *key programs.* Definition of Teams.	IAC,IAA,Mad	CMT, JLA, JIP, IPs Postdoc 1			
Meetings of preliminary *key programs* teams	IAC,IAA,Mad	JLA, JIP, IPs Postdoc1			
Elaboration and submmission of KP proposals.	IAC,IAA,Mad	JLA, JIP, IPs Postdoc1			
Organization of "seminarios especificos clave" (SECs)	IAC, IAA, Mad	IPs+Resps. Progrs. (OBJECTIVE 1)+ *team* (TBD)			
Simulations for the GTC proposals.	IAC, IAA, Mad	JAP, MGV, JIP, MML (eqteam (TBD)	During the year	During the year	During the year

(*) Mark the box associated with the corresponding months.

4.1 GANTT CHART (ONLY APPROXIMATE)

This Gantt chart should account for all the researchers included in the application and, if appropriate, also for the personal to be hired as part of the project. Underline the name of the main responsible for each task.

Activities/Tasks	Institute responsible	Person in charge and others involved	First Year (*)	Second Year (*)	Third Year (*)
OBJECTIVE 3: Public Outreach					
Press Releases	IAC, Mad, IAA	CMT+MMH+all the team+ Postdoc 1	During the year	During the year	During the year
Design of Monografic Publications	IAA, IAC,Mad	CMT, Resps programs (OBJECTIVE 1)	Coinc with the ESTALLIDOS workshop	Coinc with the ESTALLIDOS workshop	Coinc with the ESTALLIDOS workshop
Publications in peer reviews journals	IAC, IAA MADRID	PIs+ Resp. Programs (OBJETIVO 1)	During the year	During the year	During the year
Key note conferences (participation and organization)	IAC, IAA MADRID	MMH, Programs, 1,2,3,4,5,6	During the year	During the year	During the year
Workshop of ESTALLIDOS (one/year) in :TENERIFE .....GRANADA .... MADRID	IAC IAA MADRID	CMT + all the team JVM + all the team ADB + all the team	| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |	| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |	| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
Publish talks and semminar for general public (via WEB)	IAC, IAA MADRID	Ips + Postdoc 1	During the year	During the year	During the year

(*) Mark the box associated with the corresponding months.

5. PROJECT ADVANTAGES, RESULTS, SPREADING AND EXPLOITATION

(**one** page maximum).

It should outline, among others, the following items:

- Expected scientific and technical contributions from the Project; expected benefits for the advance of knowledge and technology and, if this is the case, transfer of results to the industry at short, mid and long time scales.

- Does the project fits in the priorities *in this call* and of the corresponding National Program?

- Plans to spread out and exploit the results of the project, which will be considered both during the proposal evaluation (section 9 of *the call*), and during the project follow-up.

The present project will allow us to keep studying and understanding massive star formation and evolution. It is important to emphasize that the Spanish Astrophysicists have make significant contributions to this field, both on the theoretical side and on the observational side. This prominent role is partly due to the contribution of researchers who formed part of ESTALLIDOS in some of its phases. During ESTALLIDOS 3, we expect to deepen into our understanding of the processes that trigger the star formation, and about the mechanical and chemical effects that these processes produce on the surrounding medium. We will investigate the relationships between the starburst properties and its environment (e.g., morphology and characteristics of the host galaxy, location in clusters or in the field). We will also study the possible linkage between nuclear activity and circumnuclear star formation. We will try to determine the process affecting the formation of the Lyman-α emission line, and we will compare them in the Local Universe and in primordial galaxies.

The present project fits in perfectly the *Astronomy and Astrophysics National Plan* goals since our project consolidates a leading activity in Spain by making an exhaustive use of the earth-based and space-borne observational means we have access to. Moreover, the ESTALLIDOS 3 researchers are participants of the Consolider Project *First Science with the GTC*, constituting a very active part of it. The science we propose is very suitable for the GTC instruments OSIRIS, EMIR and CANARICAM, which will be in operation within the ESTALLIDOS 3 period.

Regarding the diffusion and spreading of results, we will keep publishing them in the major journals on astronomy and astrophysics. Presentation of results in specialized conferences, and even the organization of some of the conferences, are activities familiar to all of us, as it is proven by the list of tasks carried out by the team during the last years. We organized meetings of different levels associated with ESTALLIDOS 1 and ESTALLIDOS 2, and this activity will be continued with the present project.

We consider the transmission of scientific and technical results to the society a basic component of our work. The public interest for sciences has increased notoriously over the last years, and one of our duties and goals is contributing to outreach astrophysics. The team includes several members that, in addition to their research capability, have a proven experience on teaching, popularizing, and management. As it can be seen in our CVs, over the last years some of us have already given talks in schools, secondary schools, high schools, institutes, and universities. We have also published books, popular articles on newspapers and journals, and we have participated on radio programs. The outreaching ac-

tivities within ESTALLIDOS 3 will be coordinated with the activities we are organizing in the framework of the *Consolider Program*, which has funding allocated for hiring people to work full-time in this task. The outreaching activities involving most of the researchers of our group are:

- We will continue organizing popular talks in different schools, secondary schools, and high-schools, nationwide.
- We want to establish a fluent communication channel with the media, so that we can provide first-hand information on the our scientific results, in particular, those obtained with GTC. This information must have an accessible level , and it has to be backed up with excellent graphical material.
- Staring 2008, the *Consolider Program* will promote a nationwide competition on GCT related topics involving secondary schools and high schools. We will collaborate in its organization.
- We will try to reach agreements with universities providing masters on journalism to give talks and seminars. It will allow the future journalists to get in touch with astrophysics, so that they become better qualified to transmit the our scientific vies and news.

Finally, we will continue with an activity ESTALLIDOS 2 is staring, namely, the publication of specialized monographs. This format may be the best to spread results and astronomical knowledge at a certain level, and it is a format which has not received enough attention in Spain. We have in mind both technical monographs and/or of high-level scientific popularization. The members of the ESTALLIDOS team have the required skills; they have scientific knowledge (often first-hand knowledge), but they also have a long experience in communication and teaching. At the moment we are evaluating the optimum way to carry out this type of work, and what are best possibilities for publishing.

6. BACKGROUND OF THE APPLYING TEAM ON THE PROPOSED TOPIC (In case of a Coordinated Project, sections 6. and 6.1. will have to be filled out by each of the participant teams)
(two pages, maximum)

- **Indicate the previous activities and the goals reached by the team in the topic of the project.**

  If the project continues another one previously funded, the goals and results already obtained must be clearly indicated.

  If the project deals with new topic, the records and previous contributions of the team must be indicated, so as to with justifying its capability to carry out the new project.

The project ESTALLIDOS coordinates several groups of specialists in complementary aspects of the star formation in galaxies, with the final goal of providing a framework as complete and consistent as possible to improve our understanding of the phenomenon. The core of the research team has maintained a high degree of collaboration at different levels during the last years, as it can be seen in the publication list in the annex, and in the CVs. This core is formed by a small group of senior researchers whose works in the field of active star formation in galaxies have had international impact. New collaborators joined this initial group, which has also grown out of young researchers partly formed abroad during their PhD studies and/or as postdocs. A number of these young researchers have reentered our research system, at different groups and centers, with postdoctoral fellowships and contracts *Juan de la Cierva* (hereafter JdlC) or *Ramón y Cajal* (hereafter RyC). During the two previous editions of STARBURST, 4 RyCs and 3 JdlC have been incorporated (one in each node), 2 PhD theses have been presented, and another two are about to be finished. In addition seven Diplomas of Advanced Studies (DEAs) have been obtained. Our team cannot (and does not even try to) incorporate to all the scientists formed within the group. Rather, we are proud of contributing to the enrichment of this field of research with well-prepared investigators, which also have the enthusiasm and the capability to confront the challenges of the present Spanish Astrophysics. In this way, ESTALLIDOS has also contributed to shape new research projects, that have arisen from the specialization of some of the initial research lines, and took their own way. We understand that this merging and splitting represents the natural evolution of a coordinated project, and it has allowed to keep our project within reasonable bounds.

ESTALLIDOS forms a basic part of the Consolider-Ingenio-2010 project *First Science with GTC* recently granted by the MEC. Members of the project are actively implied in projects of excellence, and in European and national collaborations and networks (e.g. MAGPOP, OPTICON; ASTROCAM). The participation of the project in outreaching and popularizing activities has been considerable (e.g. in the last SEA meeting, eight talks plus two plenary talks were presented by team members). Outreaching activities are particularly important in this edition since they directly linked to one of the three main goals, in direct relation with our contribution to the Consolider project. Past popularizing activities include talks at universities, schools, Science museums. Various papers have appeared in the journal *Investigación y Ciencia*, the Spanish edition of *Scientific American*, as well as in other scientific magazines. Classes has been taught in the Popular Universities and the Courses for adults (ULL and UCM), and we have also participated in Science Weeks.

The key of our Science is the specialization by groups of experts, keeping the common objective mentioned above. This specialization is presented in six programs. The scientific record of the team has been summarized below following these programs, where we have emphasized some key contributions made in each one of the relevant areas. (A list with all the papers published during the period of

ESTALLIDOS 2 and ESTALLIDOS 3 is given in annex 3, and it will not repeated here.) The members of ESTALLIDOS published more than 70 papers in major (refereed) international journal from January 2005 to July 2006.

Program 1: Ionized regions: auto consistent models and chemical abundances.

This is one of the programs that remains from the creation of the research group in 1991. The members of the project have contributed significantly to the study of the star formation burst. Staring with the definition and nature of the star-forming region, we pin point the classic paper by G. Tenorio-Tagle about the *champagne* model for the HII regions "*The gas dynamics of H II regions: The champagne model* " (1979, Astron. Astrophys., 71, 59), with more than 260 cites in the ADS. We have also contributed to the development of evolutionary synthesis models of stellar populations, and to the determination of the structure, electron temperature, and chemical abundance of galactic and extragalactic HII regions. Some of the related papers have become reference works in the field, e.g.,

Evolutionary population synthesis in starburst regions
J.M. Mas-Hesse, D. Kunth 1991, Astron. Astrophys. Suppl. Ser., 88, 399
On the Ongoing Multiple Blowout in NGC 604
Tenorio-Tagle, Guillermo; Muñoz-Tuñón, Casiana; Pérez, Enrique; Maíz-Apellániz, Jesús; Medina-Tanco, Gustavo
The Astrophysical Journal, Volume 541, Issue 2, pp. 720. 2000
The chemical composition gradient across M 33
Vilchez, J. M.; Pagel, B. E. J.; Diaz, Angeles I.; Terlevich, Elena; Edmunds, M. G. MNRAS.235, 633. 1988. (≥180 citations)
On the determination of temperatures of ionizing stars in H II regions
Vilchez, J. M.; Pagel, B. E. J. MNRAS.231, 257. 1998. (≥140 citations)
Abundance analysis of giant H II regions in M51
Diaz, Angeles I.; Terlevich, Elena; Vilchez, Jose M.; Pagel, Bernard E. J.; Edmunds, Michael G. MNRAS.253, 245. 1991. (≥ 80 citations)
The chemical composition of HII regions in the outer Galaxy,
Vilchez, J. M.; Esteban, C.
MNRAS. 280, 720, 1996 (≥ 100 citations)
Bidimensional Spectroscopic Mapping and Chemical Abundances of the Star-forming Dwarf Galaxy I ZW 18
Vílchez, José M.; Iglesias-Páramo, Jorge 1998. ApJ 508, 248
Line temperatures and elemental abundances in H II galaxies,
Pérez-Montero, E. & Diaz, A.I. 2003. MNRAS, 346, 105
A comprehensive study of reported high-metallicity giant H II regions - I. Detailed abundance analysis
Castellanos, M., Díaz, A.I. & Terlevich, E. 2002. MNRAS, 329, 315
An empirical calibration of nebular abundances based on the sulphur emission lines
Díaz, A.I. & Pérez-Montero, E. 2000. MNRAS, 312, 130
Hubble Space Telescope Spectroscopy of Four Luminous Compact Blue Galaxies at Intermediate Redshift
Hoyos, C.; Guzmán, R.; Bershady, M. A.; Koo, D. C.; Díaz, A. I. 2004, AJ, 128, 1541

Program 2: Galaxies Chemical Evolution. Long-term evolutionary models.

It is an emerging programm, where models and data are combined together with chemical abundances and nucleosynthesis predictions.

The nitrogen-to-oxygen evolution in galaxies: the role of the star formation rate
Mollá, M.; Vílchez, J. M.; Gavilán, M.; Díaz, A. I., 2006. MNRAS 372, 1069
Oxygen and nitrogen abundances in nearby galaxies. Correlations between oxygen abundance and macroscopic properties.
Pilyugin, L. S.; Vílchez, J. M.; Contini, T. 2004. MNRAS 425, 849
Spectroscopy of Dwarf Galaxies in the Virgo Cluster. I. Data, Chemical Abundances, and Ionization Structure
Vílchez, José M.; Iglesias-Páramo, Jorge, 2003. ApJS 145, 225
Oxygen and nitrogen abundances in Virgo and field spirals
Pyliugin, L.S., Mollá, M., Ferrini, F. & Vílchez, J.M. 2002. A&A, 383, 14
On the effect of discrete numbers of stars in chemical evolution models
Cerviño, M. & Mollá, M. 2002, A&A, 394, 525
Galactic Bulges
Mollá, M., Ferrini, F. & Gozzi, G. 2000. MNRAS, 316, 345
Evolution of Spiral Galaxies. VII. Time Evolution of the Radial Distribution of Abundances
Mollá, M., Ferrini, F. & Díaz, A.I. 1997. ApJ, 475, 519
Damped Lya Systems as Spiral Galaxies, 1997.
Ferrini,F., Mollá, M. & Díaz, A.I. 1997. ApJ, 487, L29
Evolution of Spiral Galaxies. VI. Abundance Radial Distributions in External Galaxies
Mollá, M., Ferrini, F. & Diaz, A.I. 1996. ApJ, 466, 668
Evolution of Spiral Galaxies.V. The Galactic Bulge
Mollá & Ferrini, 1995. ApJ 454, 726
Evolution of Spiral Galaxies. III. Application of the Multiphase Model to the Galactic Disk
Ferrini, F. Mollá, M. Pardi, M.C. & Díaz, A.I. 1994. ApJ 427, 745

Program 3: Structural Parameters of Galaxies
(Modeling and structural parameter determination for star-forming galaxies)

Using observations in optical and infrared wavelengths, we have established the existence of host galaxies underlying BCDs, and we have advanced on their structural modeling.

Deep Near-Infrared Mapping of Young and Old Stars in Blue Compact Dwarf Galaxies
Cairós, Luz M., Caon, Nicola, Papaderos, Polychronis, Noeske, Kai, Vílchez, José M., Lorenzo, Begoña García, & Muñoz-Tuñón, Casiana
2003, Astrophysical Journal, vol 593, pg. 312-332
Spectrophotometric investigations of the blue compact dwarf galaxy Mrk 35
Cairós, L. M., García-Lorenzo, B., Caon, N., Vílchez, J. M., Papaderos, P., & Noeske, K.
2003, Astrophysics and Space Science, vol 284, pg. 611-614
New insights into the photometric structure of Blue Compact Dwarf Galaxies from a deep Near-Infrared study.
Noeske, K. G., Papaderos, P., Cairós, L. M., & Fricke, K. J.
2003, Astrophysics and Space Science, vol 284, pg. 615-618

Our long experience in studying the relationship between galactic structure and dynamics is summarized in the following papers, which include the development of specific methods of analysis and software:

Multiband analysis of the surface brightness distributions of SB and SC spirals from CCD images. II - Bulge-disk decomposition
Prieto, M.; Beckman, J. E.; Cepa, J.; Varela, A. M.
Astronomy and Astrophysics (ISSN 0004-6361), 1992, vol. 257, no. 1, p. 85.
Multiband analysis of the surface brightness distributions of SB and SC spirals CCD images. I - Observations Prieto, M.; Longley, D. P. T.; Perez, E.; Beckman, J. E.; Varela, A. M.; Cepa, J.. Astronomy and Astrophysics Supplement Series (ISSN 0365-0138), vol. 93, no. 3, p. 557, June 1992,
Environmental Effects in the Structural Parameters of Galaxies in the Coma Cluster
Aguerri, J. A. L., Iglesias-Paramo, J., Vilchez, J. M., & Muñoz-Tuñón, C.
2004, Astronomical Journal, vol 127, pg. 1344-1359

The two following papers contain the theoretical base and the algorithms for photometric inversion and recovering of the 3D structure of galaxies.

Triaxiality in the bulges of spirals galaxies
Varela, A.M.; Simonneau, E.; Muñoz-Tuñón, C.
Galactic Bulges, Ed. Dejonghe and Habing, 1993, p.435
Spectral Inversion of the Generalized Abel Integral Transform
Simonneau, E.; Varela, A.M.; Muñoz-Tuñón, C.
J.Quant.Spectrosc.Radiat.Transfer Vol. 49, N.2, 149, 1993

Studies on dynamics and properties of bars in spiral galaxies.

A strong correlation between bar strenght and global star formation activity in isolated barred galaxies,
J. A. L. Aguerri,1999, A&A, 351, 43
Characterizing bar structures: application to NGC 1300, NGC 7479 and NGC 7723
Aguerri, J. A. L.; Muñoz-Tuñón, C.; Varela, A. M.; Prieto, M. Astronomy and Astrophysics, 361, 841, 2000
Direct Confirmation of Two Pattern Speeds in the Double-barred Galaxy NGC 2950
Corsini, E. M., Debattista, Victor P., & Aguerri, JAL., 2003, Astrophysical Journal, vol 599, pg. L29-L32
Measurement of fast bars in a sample of early-type barred galaxies
Aguerri, J. A. L., Debattista, Victor P., & Corsini, Enrico Maria
2003, Monthly Notices of the Royal Astronomical Society, vol 338, pg. 465-480

Program 4: The feedback of massive star formation (triggering of super winds, star formation confinement, super star cluster effects).

We have key contributions to the hydro-dynamical modeling of massive star burst evolution in galaxic nuclei. We have also find out how to understand observations like the ones of M82, with its filaments and structures of several Kpc (SVG). We have studied the subject from an observational side using different techniques and tools (photometry, long-slit spectroscopy, FP spectroscopy, and multi-object spectroscopy). Most of works are not included here but listed in annex 3. Here we only indicate some representative references.

On the Hydrodynamics and associated effects of the massive star bursts evolution:

Tenorio-Tagle, G., Muñoz-Tuñón, C. *Nuclear starburst hydrodynamics*
Astrophysical Journal 478, 134 (1997)
Tenorio-Tagle G., Muñoz-Tuñón, C., Perez, E. & Melnick, J.
with giant extragalactic HII regions" ApJ L 490, L179 (1997)
Tenorio-Tagle G. & Muñoz-Tuñón, C.,
The biconical kpc-structure generated by nuclear starbursts
Monthly Notices of the Royal Astronomical Society, 293, 299 (1998).
Maiz-Apellaniz, J., Mas-Hesse, M., Muñoz-Tuñón, C., Vilchez, J., Castañeda, H.O.,
"Bidimensional spectroscopy of NGC 4214: Evolutionary state and interstellar extinction"
Astronomy & Astrophysics, 329, 409-430 (1998).
On the Ongoing Multiple Blowout in NGC 604
Tenorio-Tagle,G., Muñoz-Tuñón,C.,Pérez,E. Maíz-Apellániz,J.& Medina-Tanco,G., 2000, ApJ, 541, 720.

As a result of our work, we were invited twice to write for the scientific popularization journal "Investigación y Ciencia" (Spanish edition of Scientific American) :

Muñoz-Tuñón, C. & Tenorio-Tagle, G. *"Brotes de Formacion Estelar" ("Starforming bursts")*
Investigacion & Ciencia, 279, 1999.
Tenorio-Tagle, G, Muñoz-Tuñón, C., Melo, V. & Silich, S., *"Supervientos Galácticos" ("Galactic Superwinds")* Investigacion & Ciencia, 2005.

Theoretical contributions on the effects of the interaction with the interstellar medium and the intergalactic medium for the galaxies chemical enrichment:

On the dispersal and mixing of heavy elements
Tenorio-Tagle, Guillermo NewAR 44, 365. 2000
On the fate of processed matter in dwarf galaxies
Silich, Sergey A. & Tenorio-Tagle, G., MNRAS 299, 249. 1998.
On the Energy Required to Eject Processed Matter from Galaxies
Silich, Sergiy; Tenorio-Tagle, Guillermo, 2001, ApJ, 552, 91.

Program 5: Effects of the environment on the star formation activity in galaxies (Effects on clusters and groups of galaxies)

Members of our team have produce significant contributions to the field during the last 5 years. The key of the study is considering the evolution of starburst galaxies inside a medium that acts upon them in different ways. The problem is being pursued from both observations and theory. The following list includes some of the most relevant papers that we have produced on this subject, among which one can find several invited talks in international conferences and workshops:

Star forming objects in the tidal tails of groups of galaxies
Iglesias-Páramo, J.; Vílchez, J. M. , 2001. ApJ
On the Influence of the Environment on the Star Formation Rates of a Sample of Galaxies in Nearby Compact Groups
Iglesias-Páramo, J.; Vílchez, J. M. ApJ...518, 94. 1999.

The filament of ionized gas in the outskirt of M87
Gavazzi, G.; Boselli, A.; Vílchez, J. M.; Iglesias-Paramo, J.; Bonfanti, C A&A...361,1. 2000.
A Survey of the Interstellar Medium in Early-Type Galaxies. III. Stellar and Gas Kinematics
Caon, Nicola; Macchetto, Duccio; Pastoriza, Miriani ApJS..127, 39. 2000

In this invited review in the E.S.O.conference about the environment influence on galaxies with active star formation, the existent observational evidences to support this premise are presented and discussed:

Effects of the Environment on Star Formation and Abundances in Galaxies
Vílchez, José M. Review en Chemical Evolution from Zero to High Redshift, ESO Workshop.
Edited by Jeremy R. Walsh, Michael R. Rosa. Berlin: Springer-Verlag, p. 175.1999
A survey of the ISM in early-type galaxies. I. The ionized gas.
Macchetto, F.; Pastoriza, M.; Caon, N.; Sparks, W. B.; Giavalisco, M.; Bender, R.; Capaccioli, M.
A&AS.120. 463. 1996.
Atlas of H alpha Emission of a Sample of Nearby Hickson Compact Groups of Galaxies
Vilchez, J. M.; Iglesias-Paramo, J.
ApJS 117, 1. 1998
Recent Star Formation in Groups of Galaxies: HCG 31
Iglesias-Paramo, Jorge; Vilchez, Jose M.
Ap. J. 479, 190. 199
The Environment of Star-Forming Dwarf Galaxies
Vilchez, J. M.
R.Mex AC 6, 30. 1997

One of the first contributions to the observational study of the possible environmental effects on dwarf galaxies with active star formation in different environments:

On the Spectroscopic Properties of Star-Forming Dwarf Galaxies in Different Environments
Vilchez, J. M. Astron. J. 110, 1090. 1995

Program 6: Star Formation under extreme conditions (Star formation processes in the surroundings of active nuclei: active nuclei physics, nuclear starbursts)

The members of our team have a long experience in this program. One of us was the first researcher who pointed out the importance of the large scale star formation in active galaxies. The group has been very active in the use of the ground-base data (optical and IR), as well as satellite data, like ISO (in the infrared), HST (optical), IUE and HST (ultraviolet), XMM-Newton and Chandra (X-rays). We produced some fundamental results for understanding the infrared emission of Active Galaxies, and for the comprehension of the connection SB-AGN. The papers based on X-rays are cited in annex 3, publications in ESTALLIDOS 1 and ESTALLIDOS2. The following references are representative of the work carried out before 2002:

Star Formation in Seyfert Galaxies.
Rodriguez Espinosa, Rudy, Jones.ApJ312,55, 1987
Bimodal dust emission in three classical Seyfert galaxies:NGC3227, NGC4051 and NGC4151
Rodríguez Espinosa, Pérez García , Lemke , et al., A&A 315, L129, 1996

The nature of the far IR emission from Seyfert galaxies
.Rodríguez Espinosa J.M., Pérez García A.M. ApJ 487, L33, 1997
The mid and far Infrared Spectral Energy Distribution of Seyfert galaxies.
Pérez García A.M., Rodríguez Espinosa J.M., Santolaya Rey E.ApJ 500 685, 1998
Far IR ISO Maps of Active Galaxies
Pérez García A.M., Rodríguez Espinosa J.M., Fuensalida J.J. Ap J 529, 875, 2000
A Far IR Study of the CfA Seyfert Sample. I. The Data
Pérez García A.M., Rodríguez Espinosa J.M. Ap.J., 2001, 557, 39
Multiwavelength analysis of QSO, Seyfert galaxies and starbursts
J.M. Mas-Hesse, P. Rodríguez, L. Sanz, I.F. Mirabel "" 1994, ApJS., 92, 599
Multiwavelength analysis of active galaxies: implications on unified Seyfert models
J.M. Mas-Hesse, P.M. Rodríguez, L. Sanz, et al.,1995, A&A, 298, 22
Starburst activity in X-ray and FIR luminous galaxies: The case of NGC 4619 and IRAS 1556 +6359
J.M. Mas-Hesse, M. Cerviño, P.M. Rodríguez, Th. Boller. ":" 1996, A& A, 309, 431
Nuclear spiral and ring star-forming structures and the starburst-AGN connection in barred spirals; NGC 3351 and NGC 4303
L. Colina, M. García Vargas, J.M. Mas-Hesse, et al. , 1997, ApJ , 484, L41
On the origin of the UV continuum in Seyfert 2 galaxies
L. Colina, M.L. García-Vargas, R. González-Delgado, J.M. Mas-Hesse, E. Pérez, A. Alberdi, A. Krabbe " 1997, ApJ, 488, L71
Stellar populations in the nuclear regions of nearby radio galaxies,
Aretxaga, I., Terlevich, E., Terlevich, R., Cotter, G. & Díaz, A.I. 2001. MNRAS, 325, 636
Stellar indices and kinematics in Seyfert 1 nuclei
Jiménez-Benito, L., Díaz, A.I., Terlevich, R. & Terlevich, E. 2000. MNRAS, 317, 907
V, R, I and Halpha; photometry of circumnuclear star-forming regions in four galaxies with different levels of nuclear activity.
Díaz, A.I., Álvarez-Alvarez M., Terlevich, et al.2000 MNRAS, 311, 120

Books edited by members of the PROJECT

Star formation in stellar systems
Tenorio-Tagle, G.; Prieto, M.; Sanchez, F.
(Cambridge University Press) 1992

Infrared Astronomy
Mampaso, A.; Prieto, M.; Sánchez, F.
Cambridge: Cambridge University Press, 1993

Violent Star Formation, from 30 Doradus to QSOs",
G. Tenorio-Tagle 1994
(Cambridge University Press)

The Formation and Evolution of Galaxies
C. Muñoz-Tuñón & F. Sánchez
(Cambridge University Press)

Instrumentation for large Telescopes
J.M. Rodríguez Espinosa, A. Herrero, and F. Sánchez
(Cambridge University Press)

Structure and Dynamics of the Interstellar Medium
Editores Tenorio-Tagle, Guillermo; Moles, Mariano; Melnick, Jorge
IAU Colloquium No. 120 Guido's Jubilee. 1991.
Springer-Verlag Berlin Heidelberg New York

The Evolution of Galaxies.I. Observational Clues
Editores J.M. Vílchez, G. Stasinska, E. Perez
2001. Kluwer, Dordrecht

Organization of scientific events and other activities in support of Research.

Six conference and five winter schools have been organized by members of the project, in relation to the central subject of the star formation in Galaxies and related topics. Four *workshops* of STARBURST (ESTALLIDOS) have been organized by the project (electronic publication in CD-ROM, accessible at the web page http://www.iac.es/proyect/GEFE/estallidos)

In the framework of this project, we have carried out the implementation of the software code **Mocassin,** a 3-D MOnte CArlo SimulationS of Ionized Nebulae, in the UAM Calculus Centre. A complete set of chemical evolution have also been developed. These models will be available at the WWW soon.

6.1 PUBLIC AND PRIVATE FUNDING OF THE GROUP MEMBERS (I+D PROJECTS AND CONTRACTS)

IAC Group (Only those related to ESTALLIDOS**)**

Title of the project or contract	Relation-ship with the present project (1)	Principal Investigator	Funds obtained or requested EURO	Funding organization and reference of the project	Timespan of the project or date of the applica-tion (2)
El Ciclo de la Formación Estelar en Galaxias	1	C Muñoz Tuñón	4.600.000 Ptas	DGES	Oct 98-Sep 01
Estallidos de Formación Estelar en Galaxias. El poder de las Estrellas	0	IP y Coordinadora C Muñoz Tuñón	90.151,82 €	MCYT AYA2001-3939-C03-03	Dic 01-Dic 04
Impacto de las estrellas masivas en el medio interestelar	1	IP: Sergey Silich	35000 €	CONACYT	2002 - 2004
Estallidos de Formación Estelar en Galaxias.	0	IP y Coordinadora C Muñoz-Tuñon		MCyT: AYA-2004-08260-C03-01	C 12-2004-12-2007
Evolución de Galaxias en Cúmulos	1	J. Alfonso López Ague-rri	6000€	MCyT:Programa Ramón y Cajal.	Nov 3004-Nov 2005
Consolider-Ingenio2010 Primera Ciencia con GTC.	1	J.M. Rodríguez Espino-sa	5.500.000 €	MEC. Consolider Ingenio.	Octubre 2006-Octubre 2011.

IAA Group

Title of the project or contract	Relation-ship with the pre-sent pro-ject (1)	Principal Investigator	Funds obtained or requested EURO	Funding organization and reference of the project	Timespan of the pro-ject or date of the application (2)
Estallidos de Formación Estelar en Galaxias II	0	J.M. Vílchez	136.000	AYA2004-08260-C03-02	/12/04 /12/07
Efectos del entorno en la evolución de las galaxias	1	J.M. Vílchez	3.600	Acciones Integradas HF2001-0141	2002 - 03
Estallidos I	0	J.M. Vilchez	100.796	MCYT AYA2001-3939-C03-01	28/12/01 27/12/04
Estudio de la formación estelar de galaxias en cúmulos	1	J. Iglesias	6.000	MCYT Programa Ramón y Cajal	11/04-10/05
Galaxias y Cosmología	1	J. Masegosa	31.290	Junta Andalucía – TIC 114	2003-2005
La Evolución de las Galaxias	1	J.M. Vilchez	6000	MECD	2000
The Evolution of Galaxies I,II, III	1	G. Stasinska, J.M. Vilchez, G. Hensler	123.150	Unión Europea V FP HPCF-CNF-99-1	2000 -- 2002

Madrid group

Title of the project or contract	Relation-ship with the present project (1)	Principal Investigator	Funds obtained or requested EURO	Funding organization and reference of the project	Timespan of the project or date of the applica-tion (2)
From late type giant to dwarf galaxies	1	Federico Ferrini	11.800 US$	NATO	C. 2000-2001
Estudio de la formación y evolución de galaxias en dife-rentes épocas cosmológicas y de la estructura a gran escala del Universo.	1	Angeles I. Díaz Beltrán	15120000 ptas	MCYT AYA2000-0973	C. 2001-2003
Programa OMC-Integral	2	J. Miguel Mas Hesse	2.500000 Me	MCyT: ESP95-0389-C02-02 y Acciones Especiales anuales asociadas	C 1995-2000
INTEGRAL. Fase operacional de la cámara óptica (OMC)	2	J. Miguel Mas Hesse	180.904 Euros	MCyT: ESP2001-4540-PE	C 27-05-2002 1 año
INTEGRAL. Fase operacional de la cámara óptica (OMC)	2	:J. Miguel Mas Hesse	464.400 Euros	MCyT: ESP2002-04124-C03-01	C 26-09- 2002 26-09- 2005
Estudios de definición de la cámara óptica de Eddington: EddiCam	3	J. Miguel Mas Hesse	20.434 Euros	MCyT: ESP2001-4641-E	C 7-06-2002 1 año
Estallidos de Formación Estelar en Galaxias. El poder de las Estrellas	0	J. Miguel Mas Hesse	18030 Euros	MCyT: AYA2001-3939-C03-02	C 12-2001 12-2004
Participación en el proyecto AMS	3	Javier Berdugo		McyT:ESP-2003-01111	C 1-2004 12-2006

Estallidos de Formación Estelar en Galaxias.	0	Angeles I. Díaz		MCyT: AYA-2004-08260-C03-03	C 12-2004-12-2007
Dark Energy Survey	3	Eusebio Sánchez		MCyT: AYA-2006-13735-C02-02	C 1-2007 12-2009

(*) See section 5.5 of the call for proposals

(1) Write 0, 1, 2 or 3 according to the code:
0 = the same project
1 = closely related
2 = somehow related
3 = no relation

(2) Write C or S depending on whether it has been approved (C) or it is just and application (S).

7. CAPABILITY OF THE PROJECT AND THE APPLICANT TEAM TO FORM NEW RESEARCHERS (In case of a coordinated project, each subsidiary team should fill out the section)

Complete this section only if the answer to the corresponding box in the form was filled out affirmatively. The applicat team must justify why it is capable of recieving new graduate students of the program *Formación de Investigadores* (FPI) associated to this project, and also to support its potential to form new researchers. In case of coordinated projects, only subsidiary teams requesting graduate students should complete the form.

The seed for our group can be traced back to 1990, when we submitted a proposal for using the 5% international time of the Observatories in Canary Islands in order to carry out the project GEFE (*Grupo de Estudios de Formación Estelar*; Strategic Studies of Stellar Formation). This observing time is allocated by the International Scientific Committee after an open competition among teams of various countries, provided that each team has international participation. Our proposal, lead by Prof. Tenorio-Tagle, got the observing time that year, which offered us a substantial amount of telescope time, but also the opportunity and the need to develop strategies for an efficient collaboration with a well defined purpose.

The 2001 call for Spanish research projects included the format of *coordinated projects*, very much in the vain of our needs. It allowed us to appear as the single large team that we are, despite the fact that the participants are geographically scattered throughout the country. Both the first project, ESTALLIDOS 1, as well as the present one, ESTALLIDOS 2, have been particularly successful at forming new researchers; 5 new graduate students have finished or will finish their PhD studies within the framework of our team thanks to FPI research grants directly associated with the projects. The collaboration keeps going with more experience and new members, some of which were formed as researchers in the past editions of project, and they are now full members of this new ESTALLIDOS 3. Due to our previous experience, we feel confident on the capability of our group to offer a stimulating and competent environment for the new students to begin their research experience – this aspect of the project is well covered.

During these 16 years we have supervised more than 25 PhD thesis dealing with topics closely related to this proposal. The supervision work was originally restricted only to a few team members, but the situation has changed now. Some of the former students hold post-doc positions in foreign institutions (e.g., EJB y LCB), or they have recently obtained inland positions within the programs *Ramón y Cajal* (JLA, JIP, Jesús Maíz , and Miguel Cerviño) and *Juan de la Cierva* (e.g., EJB, January 2007). More experienced former students have obtained permanent positions in various research teams in Spain (e.g., AVP, BGL). Some others opted for a leaving research, and they are now competent professionals working for private companies of various kinds.

Organized by the group in Madrid, and during the period corresponding to ESTALLIDOS 2, we have organized a special meeting for PhD students, including those of our the team. Due to the success of this event, we will organized one more before that completion of ongoing project, and we have plans for new ones during the third phase of ESTALLIDOS (2007-2010). These meetings allow the students to share experiences, stimulating scientific exchange, which optimizes the synergies resulting from the large number of participants in the team. Exactly for the same reasons, we actively promote short visits so that the students stay one or two months in a node of the network different from their home institution.

In short, we have contributed to the formation of excellent professionals, most of which keep doing a research that enriches and feeds back our work, or contribute to the development of other teams.

From now on we specify the topics of PhD theses to be carried out by the students assigned to each group.

The group of the subsidiary team in Madrid has three senior researchers with proven capability to form new students. Two of the members (Angeles Díaz and J. Miguel Mas) are teachers of the *Programa Oficial de Postgrado Interuniversitario en Astrofísica*, a 2 years master in astrophysics whose responsibility is shared by the two main public universities in Madrid (UAM and UCM), and which is meant to replace the former PhD studies. The program is sponsored by the Spanish Ministry of Education and Science (MEC). During the last 5 years, 5 theses have been completed under supervision of the team members: those of Mar Alvarez Alvarez, Marcelo Castellanos, Enrique Pérez, Elena Jiménez y Carlos Hoyos. Some of these former students participate in ESTALLIDOS 3. The group has also supervised a considerable number of DEA works (a kind of master thesis; see curricula). The present group has four graduate students supported by various grants: Rubén García Benito (FPI), Guillermo Hägele (FPU), Mónica Cardaci (FPU) , and Mariluz Martín Manjón (grant to support research from UAM). They work on topics related to programs 1 and 6 in this project. All of them have passed the DEA examination, and they are currently in a final phase of their PhD thesis work, which will be defended in 2007 and 2008. This group is able to and has sufficient means for forming **two new researchers** in topics related to the programs 1 and 2 of the project.

One of the students would work on the analysis of Lyman emission under supervision of J. Miguel Mas, which has been responsible for the PhD work of Miguel Cerviño, Jesús Maíz, and Elena Jiménez. Specifically, the work will have to develop the following activities:

- Analyze the data of nearby galaxies that we have available, in particular, the spectroscopic observations carried out with STIS-HST, the imaging from ACS-HST, and optical imaging obtained using ground based facilities.
- Comparison of Lymanα emission in objects of the local Universe, with emission in young galaxies (redshift > 2.5) using observations gathered in the large telescopes that are or will be available soon (VLT + GTC).

The second student would work on abundances and chemical evolution of barred galaxies, or on the chemical evolution of galaxies in dense environments, both under supervision of Mercedes Mollá (CIEMAT) and Ángeles Díaz (UAM).

The group of the subsidiary team in Granada has researchers with proven experience in forming students at various academic levels. On the one hand JVM has taught at graduate student level on chemical abundances of star-forming galaxies at IAC./Dpto.de Astrofísica (ULL), and he has supervised 5 PhD theses and several master thesis. In this moment JVM is in charge of 2 PhD students. On the other hand, JIP supervises 2 theses, one of them in collaboration with JVM. In addition, JIP is responsible for various introductory research works. The IAA has ideal conditions to form new students, as it is testified by the long record of successful thesis works carried out in this institution, and also by the close links existing between the IAA and the University of Granada. The IAA computer center maintains

all the main tools for reduction and analysis of astronomical observations (optical, IR and radio). The Sierra Nevada observatory, whose scientific responsibility is held by JIP, also offers fantastic training tools for new astronomers – its optical telescopes together with the 30m IRAM instrument allow us to cover two important wavelength ranges and aspects of the student's training.

Accordingly, the group is able to form **a new student**, and applies for a graduate student position to work on phenomena associated with the interaction of galaxies in clusters studied with 3D spectroscopy, as a part of program 5.

The group of the subsidiary team in the Canaries (starburst and feedback) has a number of senior members able to lead the formation of junior researchers. The two programs specifically associated with this group (programs 3 and 4) have specific objectives and working plans to develop thesis works. The group also takes active part in program number 5 and 6.
Several members of the team at the IAC are teachers of the *Programa Oficial de Postgrado en Astrofísica*, a 2 years master in astrophysics organized by the "Astrophysics Department" at La Laguna University (Tenerife).
In this moment the group has three students carrying out their thesis work: Ricardo Amorín Barbieri and Ruben Sánchez Jassen hold grants from IAC, and they are about finishing theses dealing with topics included in programs programs 2 and 5. The third student, Cristina Ramos Almeida, holds a FPI grant associated with ESTALLIDOS 2, and she is currently developing a thesis supervised by Dr. J. M. Rodriguez Espinosa on topics associated with program 6. Our group has sufficient number of senior members with solid and well established national and international collaborations, therefore, we can cope with the formation of **two new PhD students**. They would have to work on these two subjects,

- The effect of feedback in stellar formation (program 4). It is a thesis work having both an observational side and theoretical side. It will allow the student to become familiar with the observational work and, simultaneously, would demand from the student an understanding of the theoretical bases of the numerical modeling in order to appreciate its full potential and limitations.
- The role of the environment in the survival of disk galaxies (within programs 3 and 5), and the search for leftovers of disks in the diffuse intra-cluster medium. A significant part of the work would have to be devoted to developing automatic programs for searching large data bases, and for computer simulations required to prepare observations with the large telescopes available in the next future (related to objective # 2).

Appendix 1: Acronyms used in the text to name the participants in ESTALLIDOS3:

ASB Alfredo Sota Ballano
AM Ana Monreal
ALL Anna Lia Longinotti
ADB Angeles Díaz Beltrán
AVP Antonia Varela Pérez
BC Bernabé Cedrés
BP Bernard Pagel
CH Carlos Hoyos
CK Carolina Kehrig
CMT Casiana Muñoz-Tuñón
CR Carmelle Robert
CRA Cristina Ramos Almeida
DRP Daniel Reverte Payá
DMG David Martín Cordón
DV David Valls Gabaud
EDD Eduardo Delgado Donate
EH Eduardo Hardy
EduT Eduardo Telles
EC Enrico Cossini
EJ Elena Jiménez
ET Elena Terlevich
EPM Enrique Pérez Montero
GH Guillermo Hägele
GTT Guillermo Tenorio Tagle
IMD Ismael Martínez Delgado
JHF Jonatan Hernandez Fernandez
JSA Jorge Sánchez Almeida
JRE Jose Miguel Rodríguez Espinosa[$]
JLA Jose Alfonso López Aguerri
JVM Jose M Vílchez Medina
JIP Jorge Iglesias Páramo
LP Leonid Pilyugin
LCB Luz Marina Cairós
LMM Luz María Montoya
MC Mónica Cardaci
ME Matthias Ehle
MMM Mariluz Martín Manjón
MS María de Santos Lleó
MGV Marisa García Vargas
MML Mercedes Mollá Lorente
MMH Miguel Mas Hesse
MT Michael Tylor
NC Nicola Caón
NL Nora Loiseau
PR Pedro Rodríguez Pascual
RAB Ricardo Amorín Barbieri
RT Roberto Terlevich
RG Rubén García
RSJ Ruben Sánchez Janssen
SS Sergei Silich
VM Verónica Melo[$]
YE Yuri Efremov
IPs ADB, JVM & CMT

[$] They will participate as active scientific members of the project, although for administrative reasons they cannot add up to the man power with EDPs. In particular, J. M. Rodríguez Espinosa, full member of ESTALLIDOS 1 and ESTALLIDOS 2, does not appear in ESTALLIDOS3 since his EDP is fully committed as IP of the *Consolider-Ingenio "Primera Ciencia con GTC".*

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http://www.iac.es/proyect/GEFE/ESTALLIDOS/

Appendix 3: Updated list of publications resulting from work carried out within ESTALLIDOS 1 and ESTALLIDOS 2.

ESTALLIDOS 1: List of publications between January 2002 and December 2004.

1- Detection of a Super-Star Cluster as the Ionizing Source in the Low-Luminosity Active Galactic Nucleus NGC 4303
Colina, Luis, Gonzalez Delgado, Rosa, Mas-Hesse, J. Miguel, & Leitherer, Claus
2002, Astrophysical Journal, vol 579, pg. 545-553

2- Further Insights into the Structure of 30 Doradus from the Hubble Space Telescope Instruments
Walborn, Nolan R., Maíz-Apellániz, Jesús, & Barbá, Rodolfo H.
2002, Astronomical Journal, vol 124, pg. 1601-1624

3- Evolutionary synthesis models of starbursts. IV. Soft X-ray emission
Cerviño, M., Mas-Hesse, J. M., & Kunth, D.
2002, Astronomy and Astrophysics, vol 392, pg. 19-31

4- XMM-Newton observations of the Seyfert 1 galaxy Mrk 335
Gondoin, P., Orr, A., Lumb, D., & Santos-Lleo, M.
2002, Astronomy and Astrophysics, vol 388, pg. 74-87

5- Tip of the Red Giant Branch Distances to NGC 4214, UGC 685, and UGC 5456
Maíz-Apellániz, Jesús, Cieza, Lucas, & MacKenty, John W.
2002, Astronomical Journal, vol 123, pg. 1307-1315

6- Evidence for Nearby Supernova Explosions
Benítez, Narciso, Maíz-Apellániz, Jesús, & Canelles, Matilde
2002, Physical Review Letters, vol 88, pg. 081101-

7- Confidence levels of evolutionary synthesis models. II. On sampling and Poissonian fluctuations
Cerviño, M., Valls-Gabaud, D., Luridiana, V., & Mas-Hesse, J. M.
2002, Astronomy and Astrophysics, vol 381, pg. 51-64

9- Optical to Far-IR Observations of 3C 446
Leech, K. J., Saxton, R., Barr, P., Santos-Lleo, M., Jiminez-Bailon, E., Diaz, R., Ghosh, K., & Soundararajaperumal, S.
2002, Publications of the Astronomical Society of Australia, vol 19, pg. 152-154

10- Metals from star-forming dwarfs: retention or ejection?
Kunth, Daniel, Legrand, Françcois, Tenorio-Tagle, Guillermo, Silich, Sergey, Mas-Hesse, J. Miguel, & Cerviño, Miguel
2002, Astrophysics and Space Science, vol 281, pg. 261-266

11- The Massive Stellar Content in the Starburst NGC 3049: A Test for Hot-Star Models
González Delgado, Rosa M., Leitherer, Claus, Stasinska, Grazyna, & Heckman, Timothy M.
2002, Astrophysical Journal, vol 580, pg. 824-843

12- Ripples and tails in the compact group of galaxies Hickson 54
Verdes-Montenegro, L., Del Olmo, A., Iglesias-Páramo, J. I., Perea, J., Vílchez, J. M., Yun, M. S., & Huchtmeier, W. K.
2002, Astronomy and Astrophysics, vol 396, pg. 815-832

13- Is a Minor Merger Driving the Nuclear Activity in the Seyfert 2 Galaxy NGC 2110?
González Delgado, Rosa M., Arribas, Santiago, Pérez, Enrique, & Heckman, Timothy
2002, Astrophysical Journal, vol 579, pg. 188-204

15- VLT observations of metal-rich extra galactic H II regions. I. Massive star populations and the upper end of the IMF
Pindao, M., Schaerer, D., González Delgado, R. M., & Stasinska, G.
2002, Astronomy and Astrophysics, vol 394, pg. 443-457

16- Spectrophotometric Observations of Blue Compact Dwarf Galaxies: Markarian 370
Cairós, Luz M., Caon, Nicola, García-Lorenzo, Begoña, Vílchez, José M., & Muñoz-Tuñón, Casiana
2002, Astrophysical Journal, vol 577, pg. 164-182

17- Mass loss rates of a sample of irregular and semiregular M-type AGB-variables
Olofsson, H., González Delgado, D., Kerschbaum, F., & Schöier, F. L.
2002, Astronomy and Astrophysics, vol 391, pg. 1053-1067

18- The Halpha Luminosity Functions of Nearby Clusters of Galaxies
Iglesias-Páramo, J., Boselli, A., Vílchez, J. M., Cortese, L., & Gavazzi, G.
2002, Astrophysics and Space Science, vol 281, pg. 419-420

19- The velocity field of UGC 6697 revisited
Amram, P., Gavazzi, G., Marcelin, M., Boselli, A., Vílchez, J. M., Iglesias-Paramo, J., & Tarenghi, M.
2002, Astrophysics and Space Science, vol 281, pg. 401-404

20- Star-Forming Galaxies in Dense Environments
Vílchez, José M. & Iglesias-Píramo, Jorge
2002, Astrophysics and Space Science, vol 281, pg. 343-346

21- Can stellar winds account for temperature fluctuations?
Luridiana, Valentina, Cerviño, Miguel, & Binette, Luc
2002, Astrophysics and Space Science, vol 281, pg. 323-324

22- Confidence Limits of Evolutionary Synthesis Models
Cerviño, Miguel & Luridiana, Valentina
2002, Astrophysics and Space Science, vol 281, pg. 207-210

23- Chemical Abundances of NGC 5461 and NGC 5471 Derived from Echelle Spectrophotometry
Luridiana, V., Esteban, C., Peimbert, M., & Peimbert, A.
2002, Revista Mexicana de Astronomia y Astrofisica, vol 38, pg. 97-109

24- Halpha surface photometry of galaxies in the Virgo cluster III. Observations with INT and NOT 2.5 m telescopes
Boselli, A., Iglesias-Páramo, J., Vílchez, J. M., & Gavazzi, G.
2002, Astronomy and Astrophysics, vol 386, pg. 134-139

25- Mesospheric potassium layer over the Arecibo Observatory, 18.3°N 66.75°W
Friedman, Jonathan S., Collins, Stephen C., Delgado, Rubén, & Castleberg, Paul A.
2002, Geophysical Research Letters, vol 29, pg. 15-1

26- A deep Halpha survey of galaxies in the two nearby clusters Abell 1367 and Coma. The Halpha luminosity functions
Iglesias-Páramo, J., Boselli, A., Cortese, L., Vílchez, J. M., & Gavazzi, G.
2002, Astronomy and Astrophysics, vol 384, pg. 383-392

27- Temperature Bias and the Primordial Helium Abundance Determination
Peimbert, Antonio, Peimbert, Manuel, & Luridiana, Valentina
2002, Astrophysical Journal, vol 565, pg. 668-680

28- Oxygen and nitrogen abundances in Virgo and field spirals
Pilyugin, L. S., Mollá, M., Ferrini, F., & Vílchez, J. M.
2002, Astronomy and Astrophysics, vol 383, pg. 14-29

29- Detection of the 2175 Å Extinction Feature at z = 0.83
Motta, V., Mediavilla, E., Muñoz, J. A., Falco, E., Kochanek, C. S., Arribas, S., García-Lorenzo, B., Oscoz, A., Serra-Ricart, M.
2002, Astrophysical Journal, vol 574, pg. 719-725

30- The Spatial Distribution of the Far-Infrared Emission in NGC 253
Melo, V. P., Pérez García, A. M., Acosta-Pulido, J. A., Muñoz-Tuñón, C., & Rodríguez Espinosa, J. M.
2002, Astrophysical Journal, vol 574, pg. 709-718

31- Restrictions to the galaxy evolutionary models from the Hawaiian Deep Fields SSA13 and SSA22
Aguerri, J. A. L. & Trujillo, I.
2002, Monthly Notices of the Royal Astronomical Society, vol 333, pg. 633-641

32- Triaxial stellar systems following the r^{1/n} luminosity law: an analytical mass-density expression, gravitational torques and the bulge/disk interplay
Trujillo, I., Asensio Ramos, A., Rubiño-Martín, J. A., Graham, Alister W., Aguerri, J. A. L., Cepa, J., & Gutiérrez, C. M.
2002, Monthly Notices of the Royal Astronomical Society, vol 333, pg. 510-516

33- A Correlation between Light Concentration and Cluster Local Density for Elliptical Galaxies
Trujillo, I., Aguerri, J. A. L., Gutiérrez, C. M., Caon, N., & Cepa, J.
2002, Astrophysical Journal, vol 573, pg. L9-L12

34- A fast bar in the post-interaction galaxy NGC 1023
Debattista, Victor P., Corsini, Enrico Maria, & Aguerri, J. A. L.
2002, Monthly Notices of the Royal Astronomical Society, vol 332, pg. 65-77

35- On the Recent History of Star Formation in the Blue Compact Dwarf Galaxy VII Zw 403
Silich, S., Tenorio-Tagle, G., Muñoz-Tuñón, C., & Cairos, L. M.
2002, Astronomical Journal, vol 123, pg. 2438-2448

36- Intracluster Planetary Nebulae in Virgo: Photometric Selection, Spectroscopic Validation, and Cluster Depth
Arnaboldi, Magda, Aguerri, J. Alfonso L., Napolitano, Nicola R., Gerhard, Ortwin, Freeman, Kenneth C., Feldmeier, John, Capaccioli, Massimo, Kudritzki, Rolf P., & Méndez, Roberto H.
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37- On the relation between the coronal line emission and the infrared/X-ray emission in Seyfert galaxies
Prieto, M. Almudena, Pérez García, A. M., & Rodríguez Espinosa, J. M.
2002, Monthly Notices of the Royal Astronomical Society, vol 329, pg. 309-314

38- Lyalpha Emission in Starbursts: Implications for Galaxies at High Redshift
Mas-Hesse, J. M., Kunth, D., Tenorio-Tagle, G., Leitherer, C., Terlevich, R. J., & Terlevich, E.
2003, Astrophysical Journal, vol 598, pg. 858-877

39- The First Deep Advanced Camera for Surveys Lyalpha Images of Local Starburst Galaxies
Kunth, Daniel, Leitherer, Claus, Mas-Hesse, J. Miguel, Östlin, Göran, & Petrosian, Artashes
2003, Astrophysical Journal, vol 597, pg. 263-268

40- Nuclear Activity and Massive Star Formation in the Low-Luminosity Active Galactic Nucleus NGC 4303: Chandra X-Ray Observations
Jiménez-Bailón, E., Santos-Lleó, M., Mas-Hesse, J. M., Guainazzi, M., Colina, L., Cerviño, M., & González Delgado, Rosa M.
2003, Astrophysical Journal, vol 593, pg. 127-141

41- Capturing a Star Formation Burst in Galaxies Infalling onto the Cluster A1367
Gavazzi, G., Cortese, L., Boselli, A., Iglesias-Paramo, J., Vílchez, J. M., & Carrasco, L.
2003, Astrophysical Journal, vol 597, pg. 210-217

42- ``Thermal'' SiO radio line emission towards M-type AGB stars: A probe of circumstellar dust formation and dynamics
González Delgado, D., Olofsson, H., Kerschbaum, F., Schöier, F. L., Lindqvist, M., & Groenewegen, M. A. T.
2003, Astronomy and Astrophysics, vol 411, pg. 123-147

43- The detection of stellar velocity dispersion drops in the central regions of five isolated Seyfert spirals
Márquez, I.,Masegosa,J., Durret, F., González Delgado, R.M., Moles,M., Maza, J., Pérez, E., & Roth, M.
2003, Astronomy and Astrophysics, vol 409, pg. 459-467

44- Deep Near-Infrared Mapping of Young and Old Stars in Blue Compact Dwarf Galaxies
Cairós, Luz M., Caon, Nicola, Papaderos, Polychronis, Noeske, Kai, Vílchez, José M., Lorenzo, Begoña García, & Muñoz-Tuñón, Casiana
2003, Astrophysical Journal, vol 593, pg. 312-332

45- The Effect of Collisional Enhancement of Balmer Lines on the Determination of the Primordial Helium Abundance
Luridiana, V., Peimbert, A., Peimbert, M., & Cerviño, M.
2003, Astrophysical Journal, vol 592, pg. 846-865

46- On emission-line spectra obtained from evolutionary synthesis models. I. Dispersion in the ionising flux and Lowest Luminosity Limits
Cerviño, M., Luridiana, V., Pérez, E., Vílchez, J. M., & Valls-Gabaud, D.
2003, Astronomy and Astrophysics, vol 407, pg. 177-190

47- A study of H I-selected galaxies in the Hercules cluster
Iglesias-Páramo, J., van Driel, W., Duc, P.-A., Papaderos, P., Vílchez, J. M., Cayatte, V., Balkowski, C., O'Neil, K., Dickey, J., Hernández, H., & Thuan, T. X.
2003, Astronomy and Astrophysics, vol 406, pg. 453-469

48- Physical Conditions in the O++ Zone from ISO and HST Data: NGC 6543 Revisited
Luridiana, V., Pérez, E., & Cerviño, M.
2003, Astronomical Journal, vol 125, pg. 3196-3207

49- Spectroscopy of Dwarf Galaxies in the Virgo Cluster. I. Data, Chemical Abundances, and Ionization Structure
Vílchez, José M. & Iglesias-Páramo, Jorge
2003, Astrophysical Journal Supplement Series, vol 145, pg. 225-244

50- Spectrophotometric investigations of the blue compact dwarf galaxy Mrk 35
Cairós, L. M., García-Lorenzo, B., Caon, N., Vílchez, J. M., Papaderos, P., & Noeske, K.
2003, Astrophysics and Space Science, vol 284, pg. 611-614

51- Stellar population gradients in Seyfert 2 galaxies: northern sample
Raimann, D., Storchi-Bergmann, T., González Delgado, R. M., Cid Fernandes, R., Heckman, T., Leitherer, C., & Schmitt, H.
2003, Monthly Notices of the Royal Astronomical Society, vol 339, pg. 772-792

52- Imaging polarimetry of stellar light scattered in detached shells around the carbon stars R Scl and U Ant
González Delgado, D., Olofsson, H., Schwarz, H. E., Eriksson, K., Gustafsson, B., & Gledhill, T.
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53- Non-confirmation of reported HI clouds without optical counterparts in the Hercules cluster
van Driel, W., O'Neil, K., Cayatte, V., Duc, P.-A., Dickey, J. M., Balkowski, C., Hernández, H., Iglesias-Páramo, J., Papaderos, P., Vílchez, J. M., & Thuan, T. X.
2003, Astronomy and Astrophysics, vol 399, pg. 433-439

54- On the origin of nitrogen
Pilyugin, L. S., Thuan, T. X., & Vílchez, J. M.
2003, Astronomy and Astrophysics, vol 397, pg. 487-501

55- The r'-band luminosity function of Abell 1367: A comparison with Coma

Iglesias-Páramo, J., Boselli, A., Gavazzi, G., Cortese, L., & Vílchez, J. M.
2003, Astronomy and Astrophysics, vol 397, pg. 421-430

56- A photometric monitoring of bright high-amplitude delta Scuti stars. II. Period updates for seven stars
Derekas, A., Kiss, L. L., Székely, P., Alfaro, E. J., Csák, B., Mészáros, Sz., Rodríguez, E., Rolland, A., Sárneczky, K., Szabó, Gy. M., Szatmáry, K., Váradi, M., & Kiss, Cs.
2003, Astronomy and Astrophysics, vol 402, pg. 733-743

57- Direct Confirmation of Two Pattern Speeds in the Double-barred Galaxy NGC 2950
Corsini, E. M., Debattista, Victor P., & Aguerri, J. A. L.
2003, Astrophysical Journal, vol 599, pg. L29-L32

58- On the formation of massive stellar clusters
Tenorio-Tagle, G., Palous, J., Silich, S., Medina-Tanco, G. A., & Muñoz-Tuñón, C.
2003, Astronomy and Astrophysics, vol 411, pg. 397-404

59- Supergalactic Winds Driven by Multiple Super-Star Clusters
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