# FLARE IN THE OUTER DISK OF THE MILKY WAY

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See further details at López-Corredoira & Molgó (2014)

We explore the outer Galactic disc up to a Galactocentric distance of ≈30 kpc to derive its parameters and measure the magnitude of its flare.
We obtain the 3D density of stars of type F8V-G5V with a color selection from extinction-corrected photometric data of the Sloan Digital Sky Survey – Sloan Extension for Galactic Understanding and Exploration (SDSS-SEGUE) . Comparing with a flared and non-flared exponential disk model, the data show evidence in favor of the flared model. Our best fit gives a flare that causes the scale height of the average disc to be multiplied with respect to the solar neighborhood value by a factor of $3.3^{+2.2}_{-1.6}$ at $R$ = 15 kpc and by a factor of $12^{+20}_{-7}$ at $R$ = 25 kpc.
This prominent flare explains the apparent depletion of in-plane stars that are often confused with a cut-off at $R \gtrsim 15$ kpc.
Moreover, the smoothness of the observed stellar distribution also suggests that there is a continuous structure and not a combination of a Galactic disc plus some other substructure or extragalactic component: the hypothesis to interpret the Monoceros ring in terms of a tidal stream of a putative accreted dwarf galaxy is unnecessary.

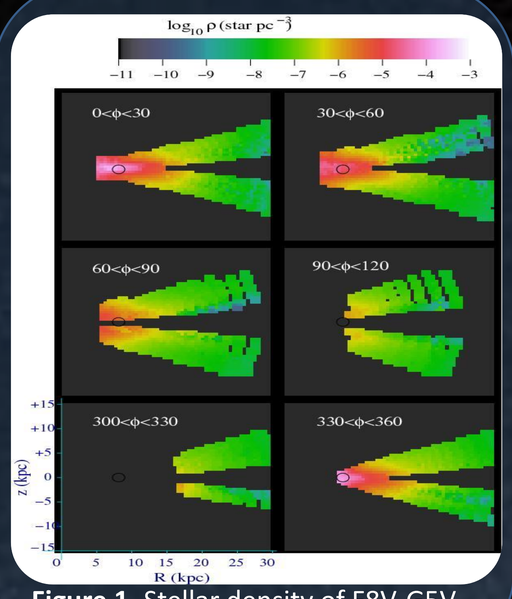


**Figure 1.** Stellar density of F8V-G5V stars from SDSS data

## Outer Galactic disk stellar space density computation

In this work we aim to study the stellar density in the outer galactic disk. In the inner 15 kpc, red clump stars have been used as standard candles using NIR photometry, but in further distances this is inappropriate, as they become confused with nearer dwarf stars.
Here, we use the photometry in the visible from SDSS-SEGUE to select dwarf stars ranging from F8V spectral class to G5V. If the extinction is low, these stars can be isolated using color with only minimal contamination from other sources.
In the selection query we exclude the |l|<50° region (to avoid the inner galaxy), the |b|>23° region (to avoid non-disk stars), and the |b|<8° (due to excessive extinction). All the magnitudes used have been corrected using the Galactic extinction model of Schlegel et al. (1998).

**Once the stars are selected, the differential star counts A(m) in each of sight are used to derive the density $\rho$ :**

$$\rho[r(m)] = \frac{A(m)}{\omega r(m)^3}\frac{5}{\ln 10}$$
$$r(m) = 10^{[m-M+5]/5}$$

## Galactic disk model fit

Once computed the 3D stellar density, we proceed to derive the disk structural parameters. We use a standard $\chi^2$-fit algorithm with a flared thick and thin exponential disk model, where the scale height changes with the galactocentric radius R as

$$h_{z,\{thin,thick\}}(R) = h_{z,\{thin,thick\}}(R_o)\left(1 + \sum_{i=1}^{2} k_{i,}\,(R - R_o)^i\right)$$

The best fit solution is displayed in Figure 2. There is clear evidence that the measured star densities diverge from the pure exponential model, whilst the flared solution agrees well to the data. The best fit parameters are:

| Parameter | Value | Parameter | Value |
|---|---|---|---|
| $\mathbf{h_{r,thin}(kpc)}$ | $2.0^{+0.3}_{-0.4}$ | $\mathbf{k_{1,thin}(kpc^{-1})}$ | -0.037 |
| $\mathbf{h_{z,thin}(kpc)}$ | $0.24^{+0.12}_{-0.01}$ | $\mathbf{k_{2,thin}(kpc^{-1})}$ | 0.052 |
| $\mathbf{h_{r,thick}(kpc)}$ | $2.5^{+1.2}_{-0.3}$ | $\mathbf{k_{1,thick}(kpc^{-1})}$ | 0.021 |
| $\mathbf{h_{z,thick}(kpc)}$ | $0.71^{+0.22}_{-0.02}$ | $\mathbf{k_{2,thick}(kpc^{-1})}$ | 0.006 |

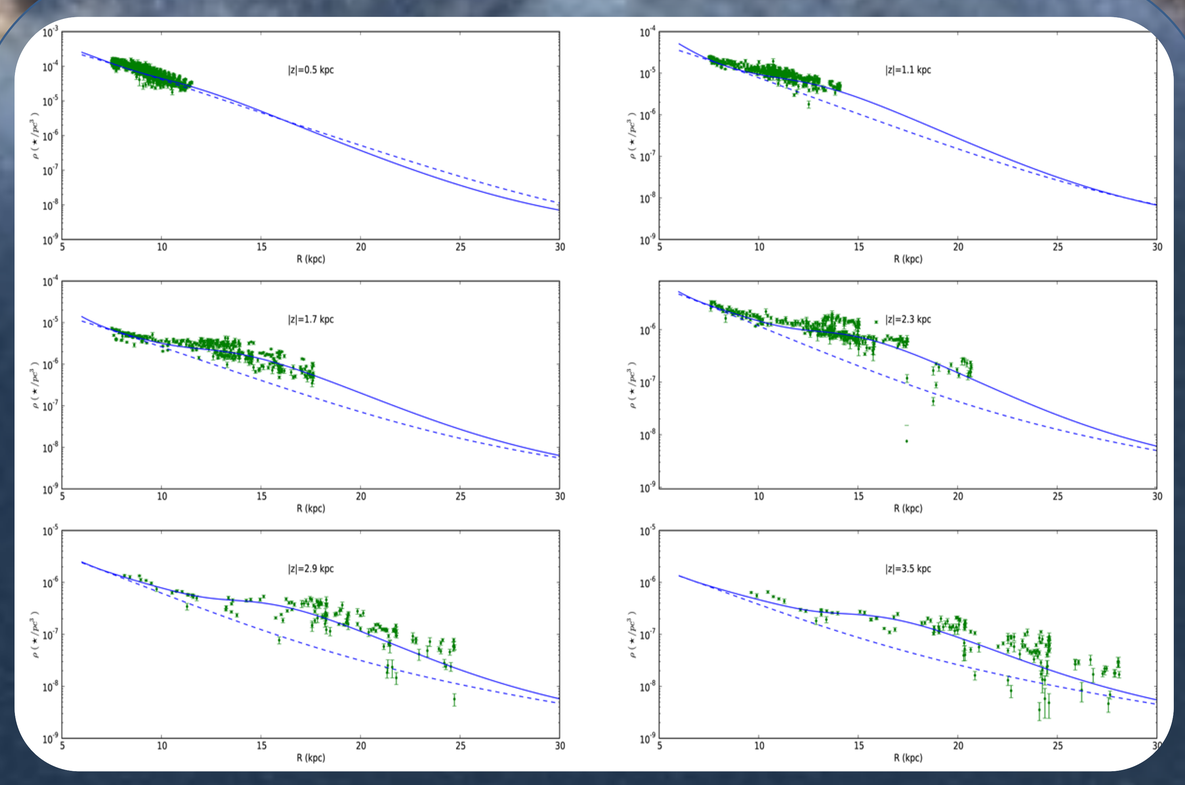


**Figure 2.** The green dots show the stellar density of F8V-G5V stars as a function of R. The solid line shows the best fit for the flared disk model, and the dotted line is the best fit for the non flared model

## Conclusions

- We have selected F8V-G5V disk stars using dereddened colors from SDSS-SEGUE photometry.
- Exploiting the narrow range of intrinsic absolute magnitudes of the selected set, we have derived spatial stellar densities and fitted a exponential thin and thick disks models. The flared model follows smoothly the observed densities, whilst the non-flared model cannot explain them. The scale height at R=25 is higher than the one at Ro by a factor of 12.
- Our data indicate that there are stars beyond 15 kpc, which questions the cut-off hypothesis as stated by Ruphy et al. (1996) or Minitti et al. (2011). There are less stars in the plane than the predicted by a pure exponential disk because they are spread away to higher regions by the flare.
- The smoothness of the observed stellar distribution also suggests that there is a continuous structure and not a combination of a Galactic disc plus some other substructure. The hypothesis of a tidal stream from an accreted galaxy to explain the Monoceros ring (Sollima et al. 2011; Conn et al. 2012; Meisner et al. 2012) is, then, unnecessary.

**References**

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