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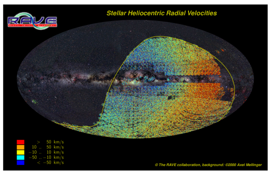


The RAVE observations
The fourth data release of the RAVE survey (Kordopatis et al. 2013) contains stellar measurements of about 480 000 stars in the magnitude range 8 < I < 12 mag. Measurements for each star include radial velocity, effective temperature, gravity and metallicity.

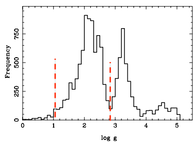
Mapping the Galactic gravitational potential with Rave data

Summary

- We select 5000 Red Clump stars towards the South Galactic Pole from RAVE observations.
- Their density distribution and their velocity dispersion allow us to measure the vertical variation of the gravitational potential $\Phi(R,z)$
- We deduce the total galactic mass distribution in the solar neigbhourhood and determine the local density of dark matter.

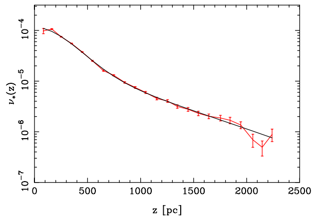
1) The red clump RAVE stars

- RAVE spectroscopic observations with R=7500 allow us to select 5000 red clump stars |z|<2 kpc and close to the solar position $(dist^2-z^2)^{(1/2)} < 0.5$kpc
  - We select red clump RAVE stars towards the South Galactic Pole: J-K colour within [0.5,0.8] and log g within [1.,2.8]
  - We determine the positions and velocities. Accuracy is 8% on distances and 2km/s on vertical Galactic velocities.



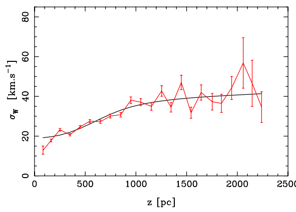
2) The Vertical Density of Red Clump Stars

- We determine the counts of red Clump stars towards the SGP, from 2 mass star counts with J-K within [0.5,0.8], from counts of observed RAVE stars, and counts of Red Clump RAVE stars.
- We deduce the vertical stellar density distribution $\nu_*(z)$ of RC stars towards the SGP



3) The Kinematics of Red Clump Stars towards the SGP

- We determine the vertical velocity dispersions versus z. Individual stellar velocities are measured from RAVE radial velocities and UCAC3 proper motions



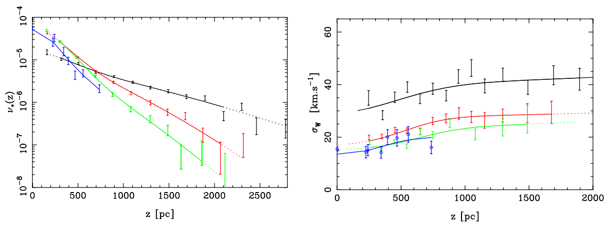
4) How do we measure the galactic vertical potential $\Phi(z)$?

- The vertical galactic potential is determined from the comparison of the vertical density of red clump stars $\nu_*(z)$ and vertical velocity dispersion $\sigma_W(z)$.
- To improve this determination, the RC sample is splitted in 3 samples with different metallicities that probe different z intervals.
- A 3D galactic model of the potential is necessary to properly consider the coupling between radial and vertical motions.
- This is done using a Stäckel potential
- The distribution function **f(z,w)** of disk stars is modelled with a Shu DF generalized for 3D Stäckel potentials

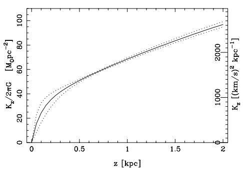
- The main free parameters of the potential are:
  - ρ_{DM} The local dark matter density
  - Σ_0 The total surface mass density at R_0
  - The thickness of the disc mass density

5) How do we measure the galactic vertical potential $\Phi(z)$?

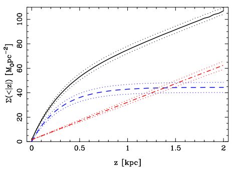
- The free parameters are determined by simultaneously fitting the vertical density and vertical dispersion of each of the three metallicty sample of RAVE RC stars and a fourth local sample (Bienaymé et al. 2006)
  - Black [M/H]<-0.35
  - Red -0.35<[M/H]<-0.15
  - Green -0.15<[M/H]
  - Blue : an independent sample of nearby RC towards the NGP



6) The vertical force Kz and the total surface mass density



The vertical force Kz, perpendicular to the Galactic plane, and 1-σ error intervals



Total surface mass density (black) $\Sigma(<|z|) = \int_{-z}^{z} \rho_{tot} dz$

split in in Dark Matter component (red) and in a baryonic disk (blue)

7) The suface mass density and the local dark matter density

- Our Kz force determination is similar to the other analysis previoulsy done below z=1 kpc
- Between z=1 and 2 kpc the Kz force variation is almost entirely dependent on the DM mass density.
- We find the total surface density of the disk component at the solar position:

$$\Sigma_{disc}(R_0) = 44.4 \pm 4.1\, M_\odot pc^{-2}.$$

- The Oort limit, the total volume density at z=0:

$$\rho_{total}(z=0) = 0.091 \pm 0.0056\, M_\odot pc^{-3}$$

- The local volume density of the dark matter component:

$$\rho_{DM}(z=0) = 0.0143 \pm 0.0011\, M_\odot pc^{-3} = 0.54 \pm 0.004\, Gev\, cm^{-3}.$$

8) Discussion

- Our determination of the Kz force reaches larger z-distances than in previous studies, probing a domain where the mass density is dominated by the DM.
- We find a local volume DM density twice what was previously admitted
- If the DM halo is spherical, our finding implies that the velocity curve at the solar position R_0 is $V_0(R_0)$=267 km/s
- Our result is in agreement with currently accepted value of V_0 (R_0) (from 200 to 240 km/s) if the DM halo is slightly flattened with an axis ratio 0.8. Our result is also compatible with the presence of a very thick disc of DM, a secondary dark component resulting from the accretion of dark matter from accreted satellites (Read et al 2009).
- Our results also imply a cored dark matter profile whose density does not drop sharply with radius.

References

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