Arms coinciding with resonances and star formation in the Galactic disk

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Summary

Once you know for sure the position of one resonance in our Galaxy, you automatically know where are all the others. Just because you know Ω p – the pattern rotation speed.

Then, you can recognize the effects of the resonances and start to understand the nature of the "spiral" arms.

We first determined Ωp by integrating the orbits of the open clusters up to their birthplaces, and observing how the birthplaces (the arms) move as a function of time. (Dias et al., 2008)

The position of corotation (1 kpc beyond the Solar circle) was confirmed by the discovery of a Cassini-like gap in the HI distribution. This gap was predicted by theory. (Amores, Lepine & Mishurov, 2009).

The corotation gap acts as a barrier which isolates the gas of one side from the other. It is responsible for the existence of a step of 0.3 dex in the metallicity distribution (Lepine et al. 2011).

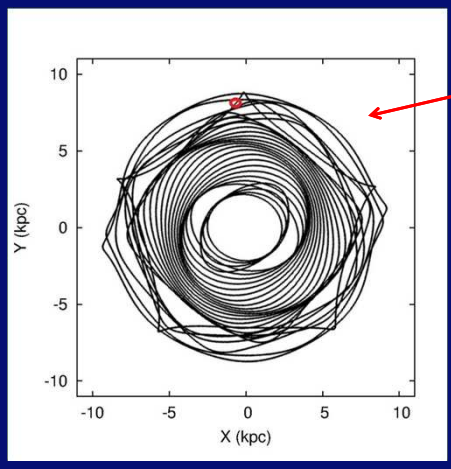
The 4:1 resonance (4 epicycles in one turn around the Galaxy in a frame rotating with velocity Ωp) can be recognized from the square-shaped arm that it produces. One of the "corners" of this arm is at less than 1 kpc from the Sun.

The 5:1 resonance is also very near the Sun. Most of the stellar associations of the solar neighborhood have "pentagon-like" orbits in the Ωp frame .

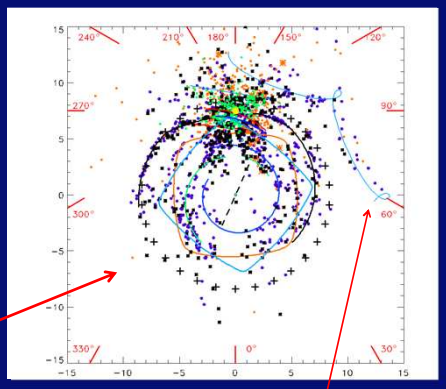
What is a spiral arm?

A "spiral" arm is a concentration of stellar orbits that pass close together. This locally increases the density of matter, and consequently form a kind of channel in the gravitational potential of the disk. The gas of the disk , as it rotates, falls into the potential channels, and form stars.

The shape of the arms is governed by the shape of the stellar orbits, not by shock waves in the interstellar medium, by stochastic processes of sequential star formation, etc.



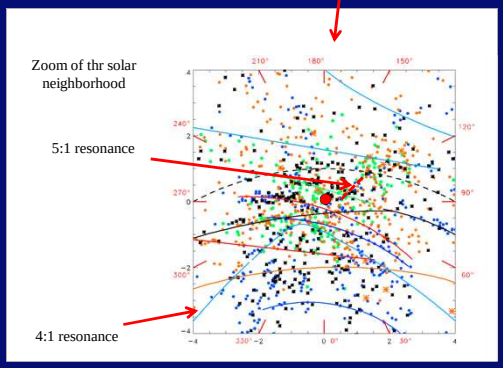
A model for the orbits in the Galaxy
The sequence of orbits with increasing radii is generated automatically by a program which looks for closed orbits.(Poincaré method) The position of the Sun is indicated by a red circle

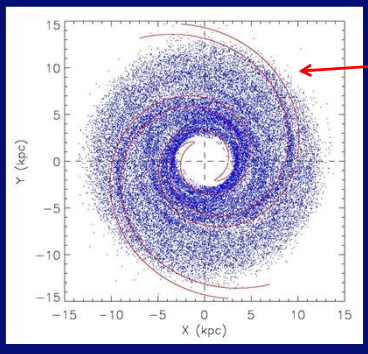


Our Galaxy mapped with the CS sources of Bronfman et al 1996. Blue: CS,green: open clusters orange:Cepheids

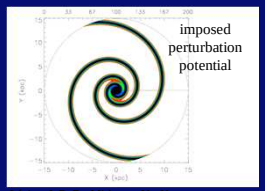
Our Galaxy (above) presents an arm with reverse curvature similar to that of M74 (below). Such arms are easily explained by a resonance

The spiral arms are like the Victoria Falls: a channel in the gravitational potential. The gas of the disk is trpped by the channel, flows along the channel, and form stars with initial velocities aligned with the arm

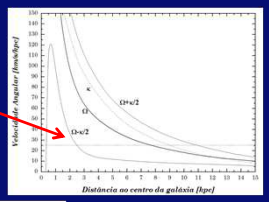


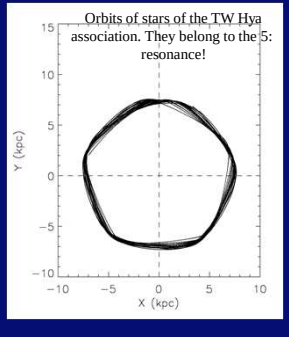


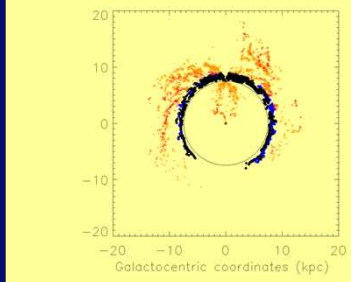
Self-consistency: we start with an imposed potential perturbation in form of a logaritmic spiral channel (indicated by the red line) The stars are uniformly spread over the disk. After a few hundred thousand years, tthe stars are found concentrated along the channels, and a produce a potential similar to the initially imposed one.



The position of the resonances depend only on the adopted Ωp







The Cassini-like ring void of HI which coincides with corotation as predicted by theory

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