Oxygen Distribution Breaks at Corotation Radius in Spiral Galaxies

Institutions:

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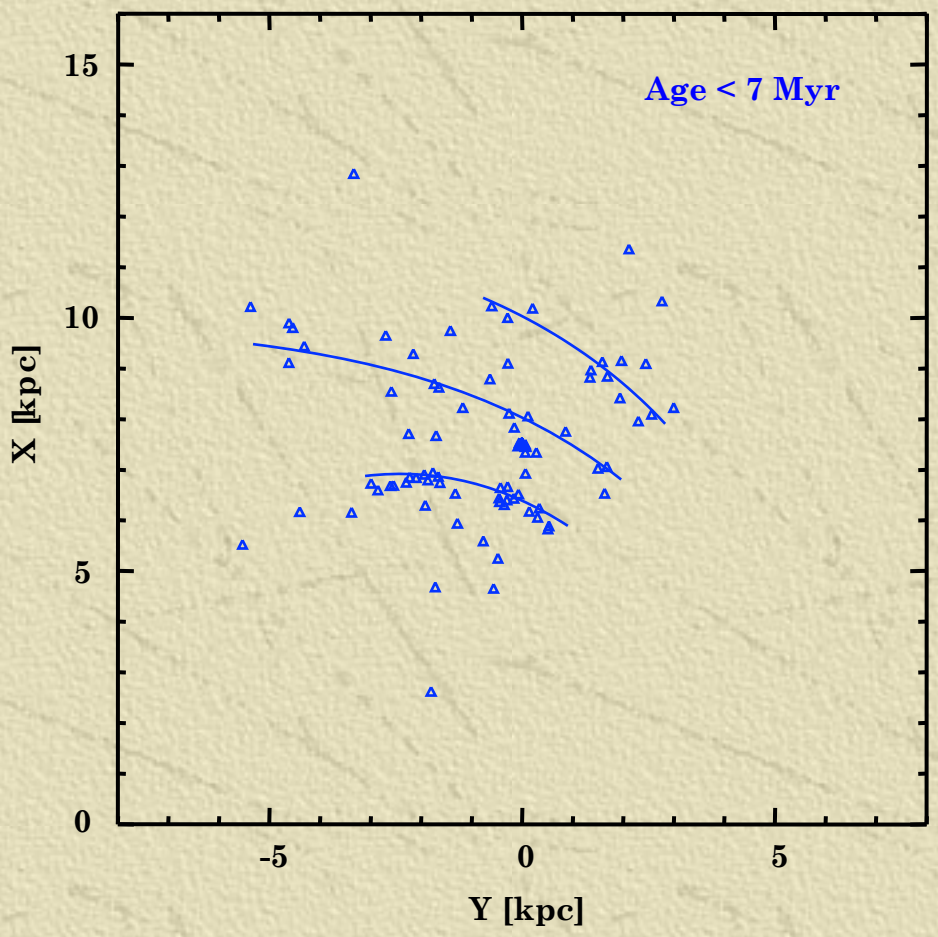
Open Clusters as Spiral Arms Tracers

In our Galaxy it is possible to use open clusters to trace the spiral arms in different moments in the past, using their ages and the proper motions of their stars.



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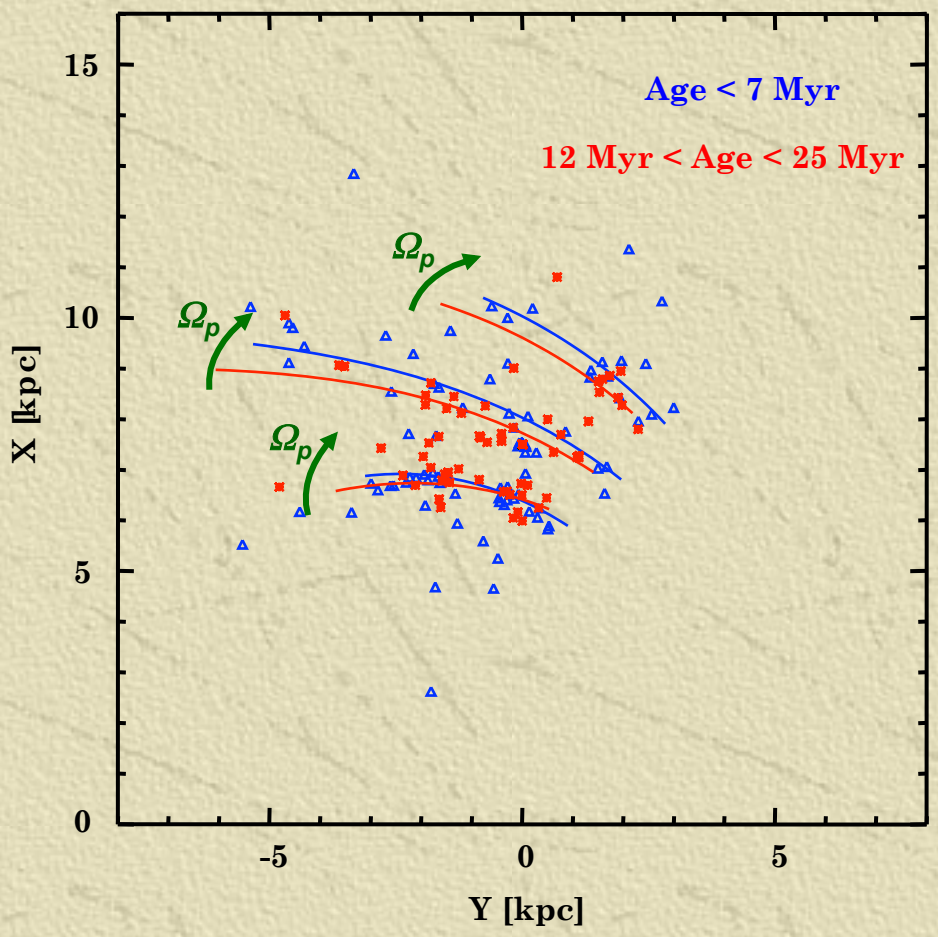


According Dias & Lépine (2005):

Ω_p = 24 km/s/kpc

The Corotation Radius Concept

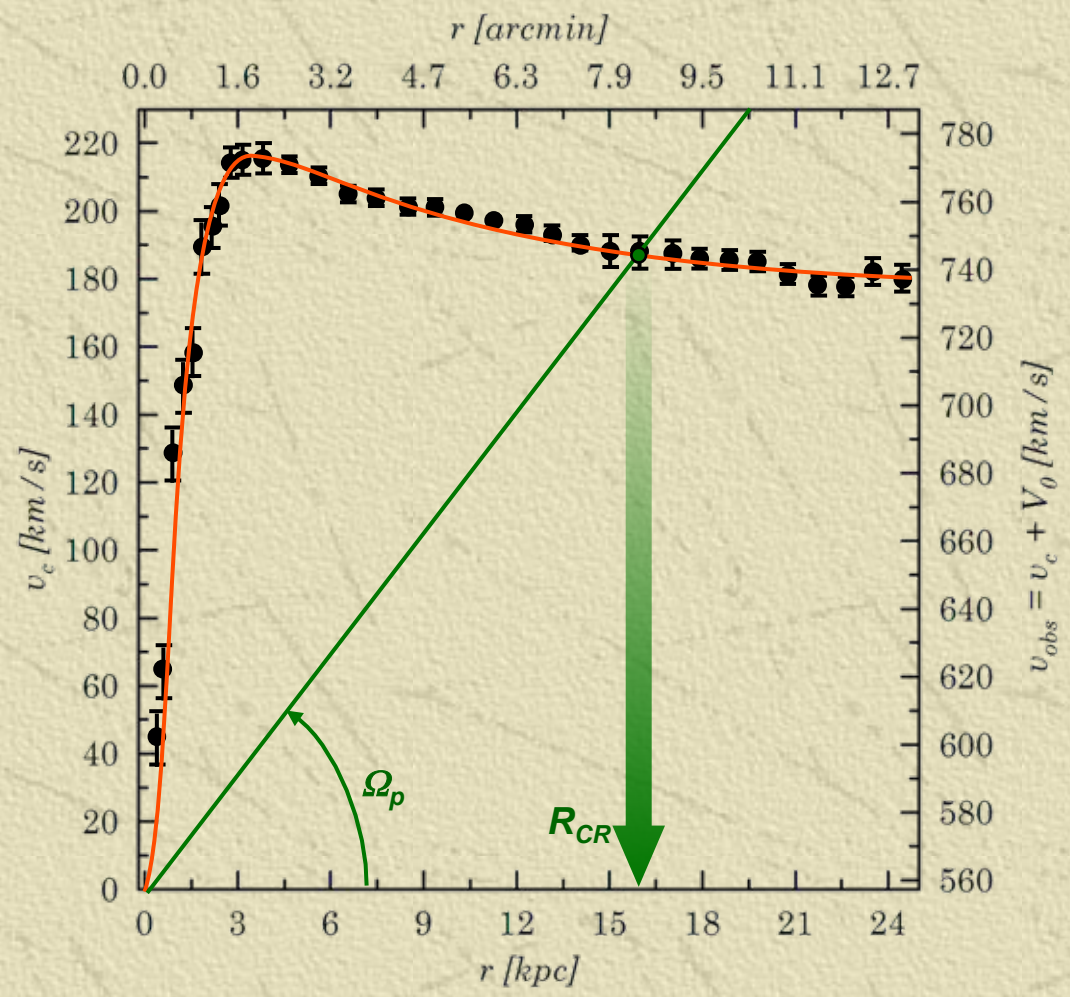
Assuming that the spiral pattern is stable, the corotation radius is the place in a galaxy where the spiral pattern rotates at the same velocity of the material that follows the the rotation curve.

Rotation curve of the disk (differential rotation)

=

Rotation curve of the spiral arm (rigid body)

Corotation radius (R_C)



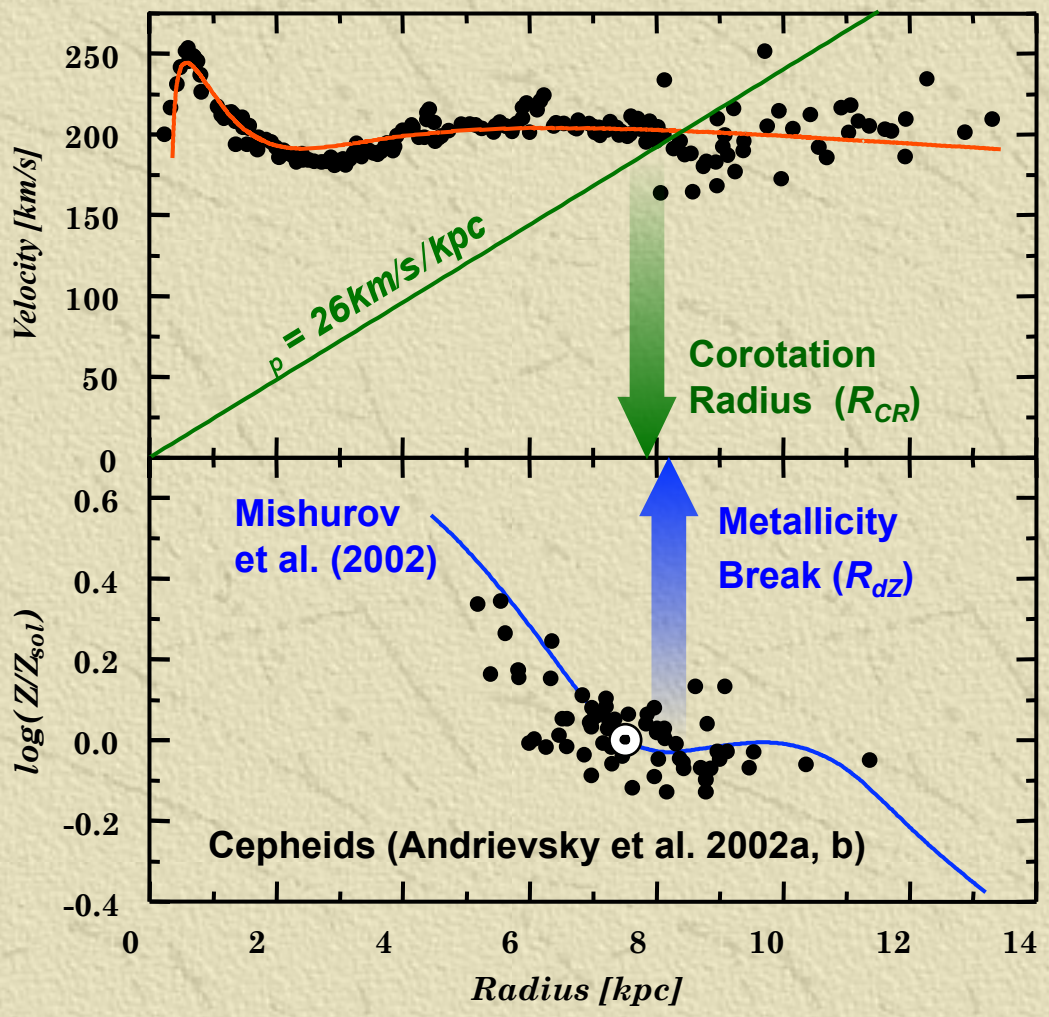
The Role of the Spiral Arm in the Oxygen Abundance

Spiral arms trigger the star formation. Different chemical elements are synthesized and released during the life and death of stars. Type II supernovas are the main contributors to the Oxygen enrichment.

Type II Supernovas (Formed in the Spiral Arms

A Chemical Evolution Model for our Galaxy

A simple model which assumes the star formation rate (SFR) is proportional to $\Sigma \cdot |\Omega - \Omega_p|$, is able to reproduce the observed metallicity distribution of cepheids in our Galaxy.



Rotation Curve and Corotation

1-) Clemens (1985);

2-) Distances recalibrated to d_{sun} = 7.5 kpc;

3-) Spiral pattern speed by Dias & Lépine (also recalibrated).

Cepheids Metallicity Gradients

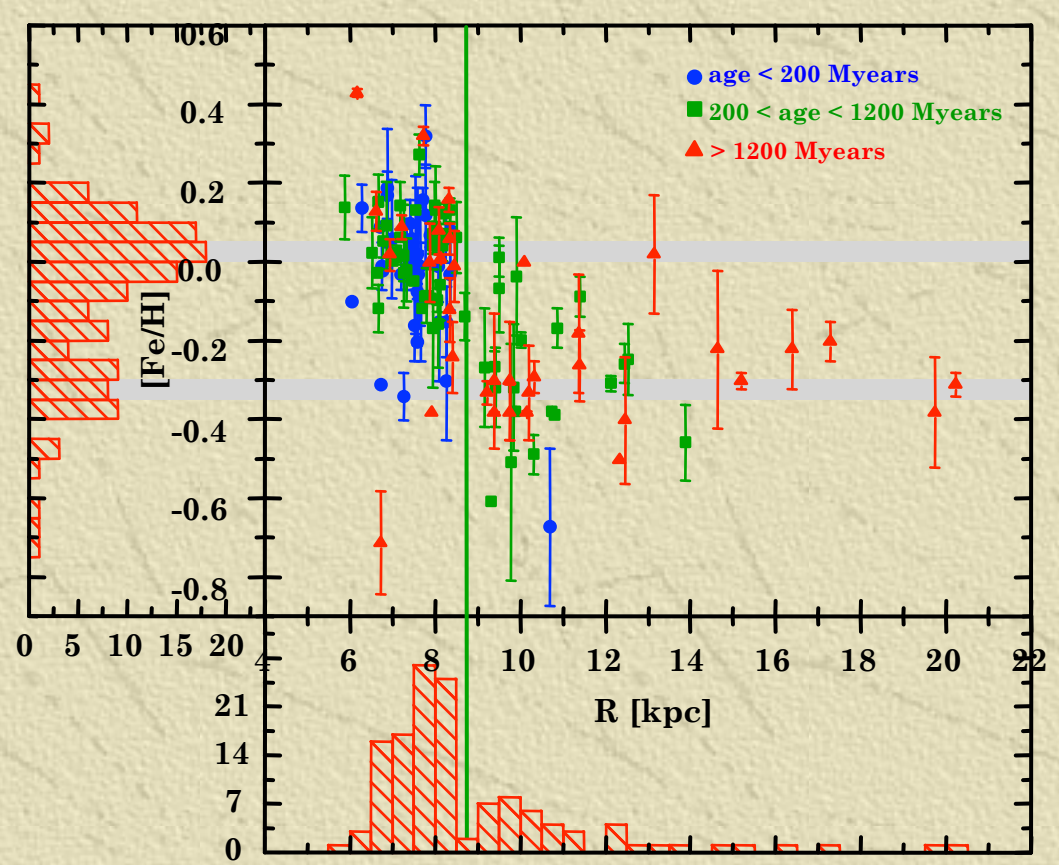
1-) Precise distances;

2-) Bright objects;

3-) Reliable abundances (at least in the context of the disk of our galaxy)

Metallicity Distribution of Open Clusters in Our Galaxy

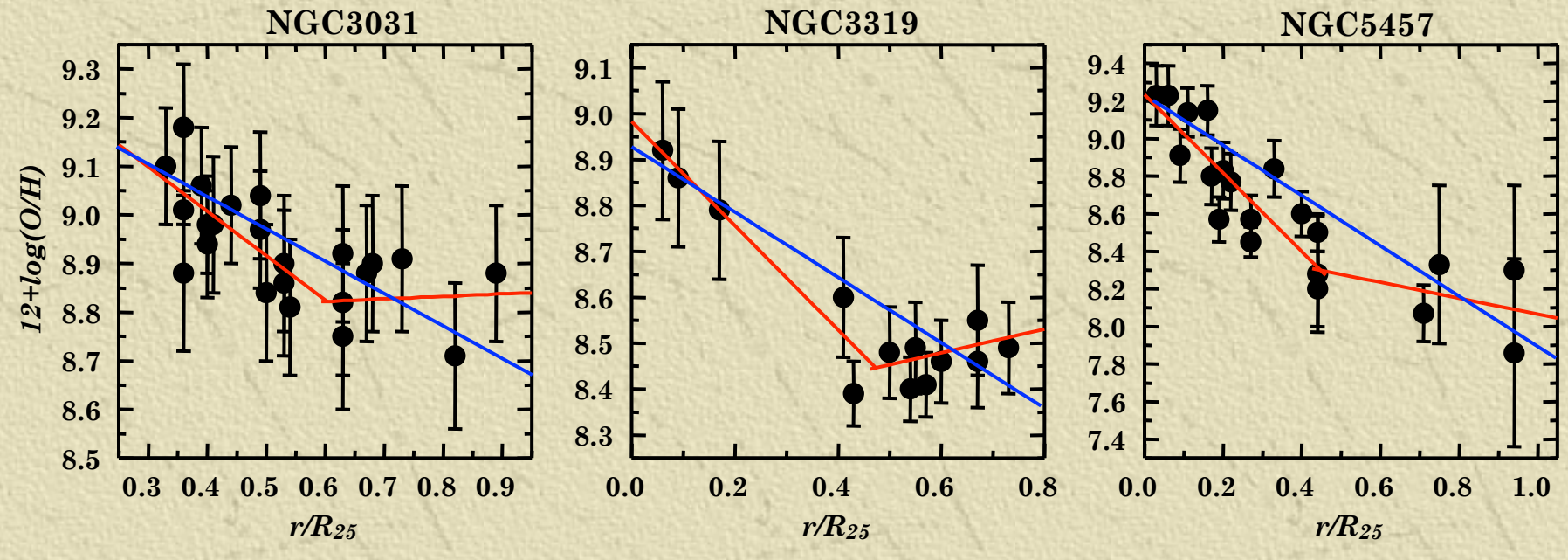
The bimodal metallicity and the radial distribution of open cluster in our galaxy reinforces the evidences of a secular effect of the corotation radius in the radial galactic chemical abundances.



Lépine et al. (2011)

Radial Oxygen Abundance Breaks in the Literature

It is not rare to find galaxies for which a simple linear model does not fit the Oxygen abundance distribution properly.



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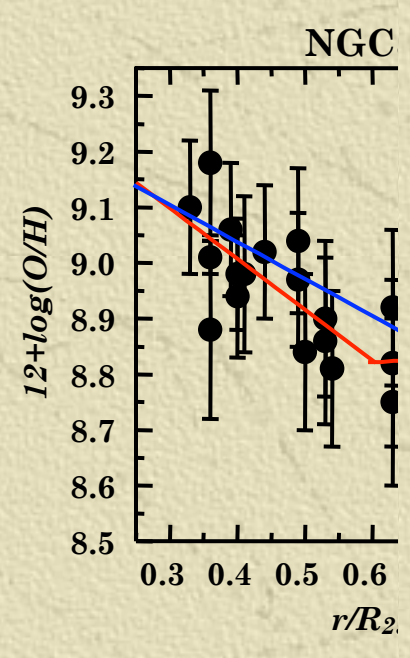
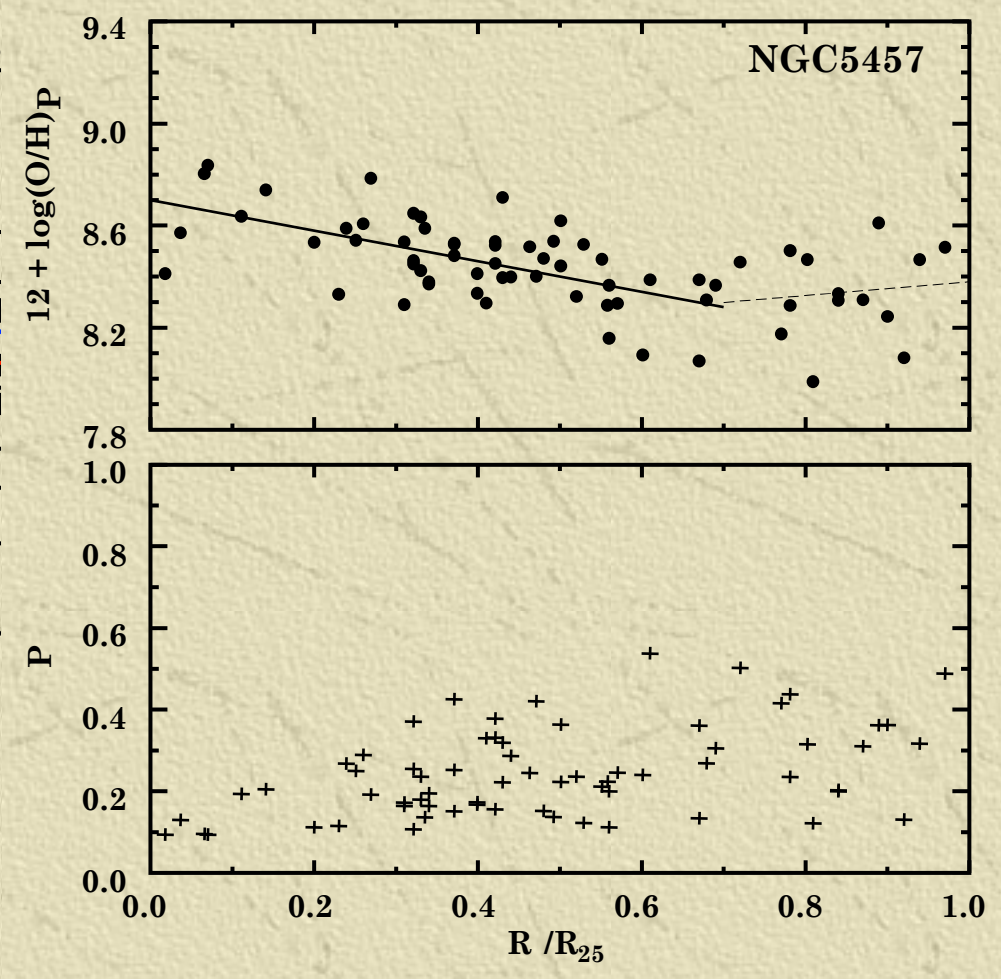
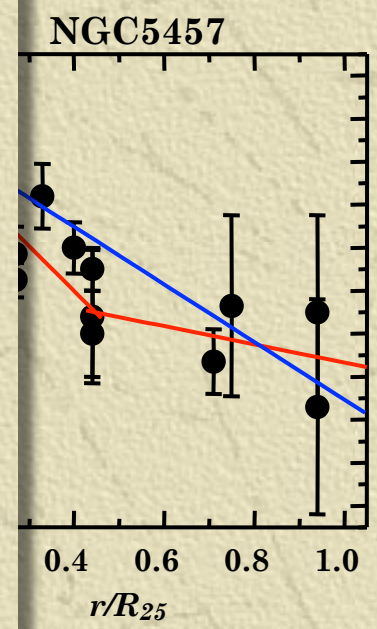




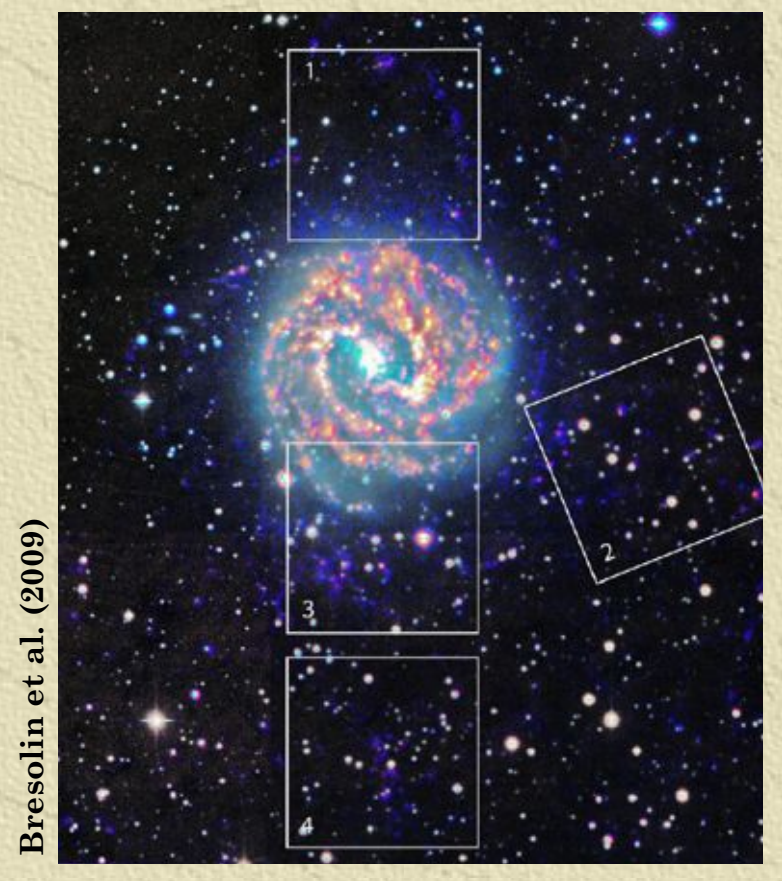


Zaritsky et al. (1994)

Pilyugin (2003): Bends associated to systematic errors (P parameter) and limits in the abundance regimes

Breaks in the Oxygen Abundance – M83 case

Bresolin et al. (2009) verified with new observations and different calibrations a break in the radial oxygen distribution of M83.



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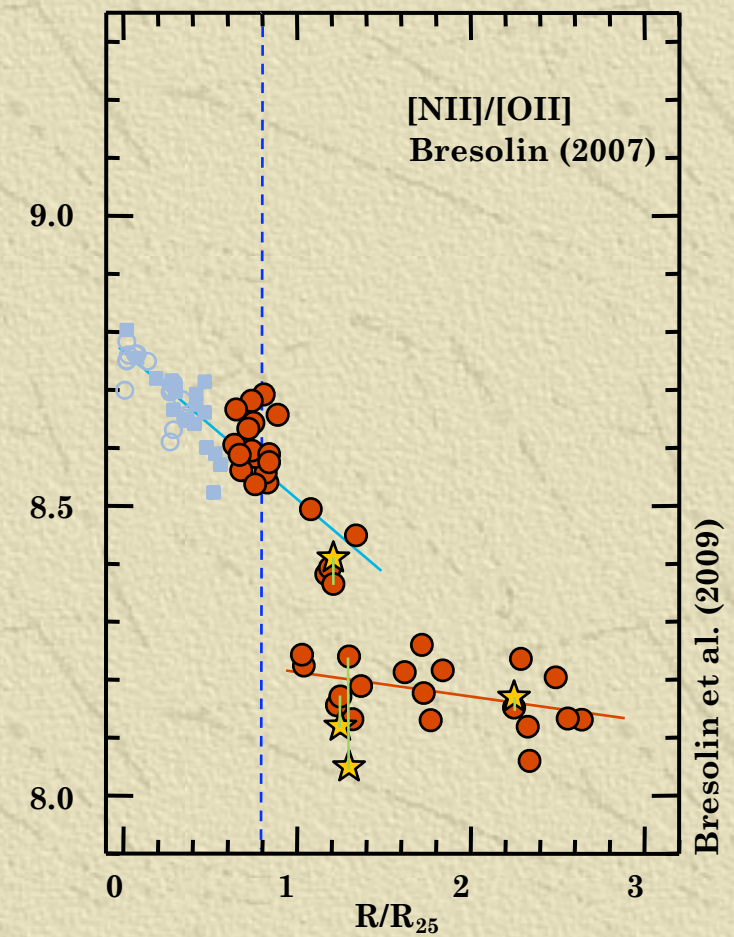
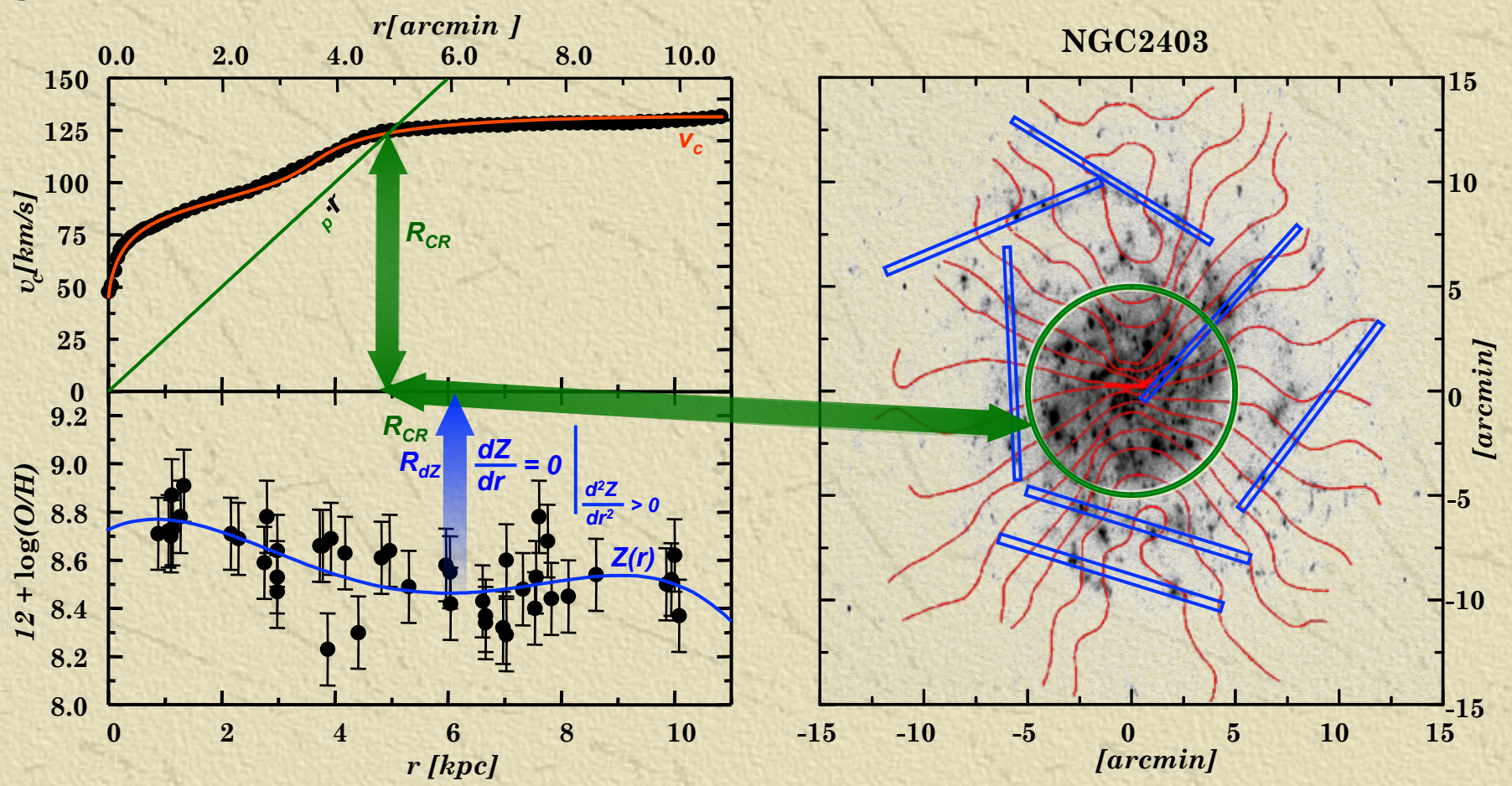


Bresolin et al. (2009)

Other examples by Zahid & Bresolin (2011) and Scarano Jr et al. (2011).

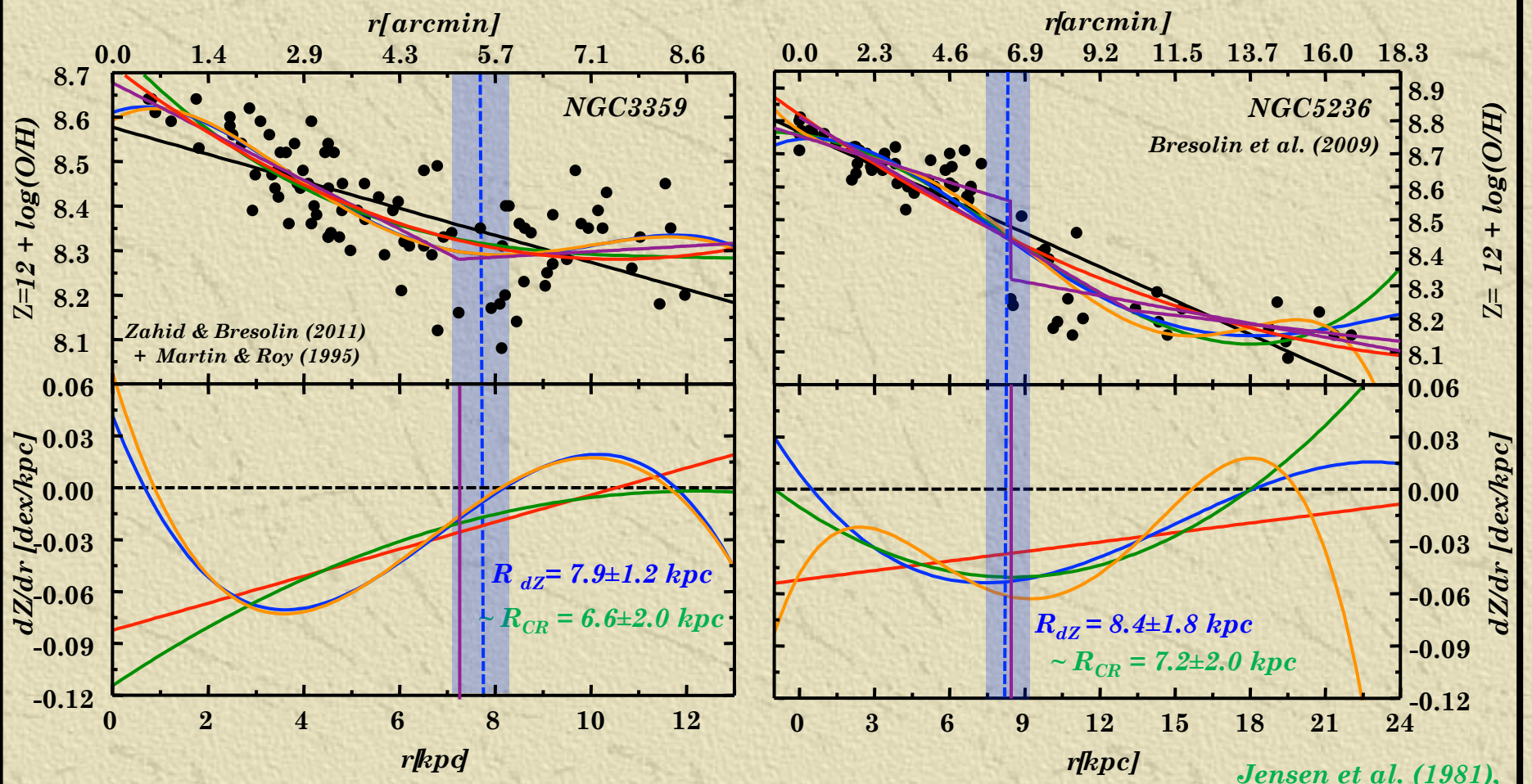
Compiling References and Standardizing Data

To investigate the role of the corotation in the metallicity distribution we compiled: 1-) rotation curves; 2-) radial metallicity distributions; 3-) corotation radius or spiral pattern speeds from the literature for 27 spiral galaxies.



Identification of Breaks in Metallicities Distributions

In abundances distributions with breaks, sometimes polynomial or functions with steps fit the data better than linear fit (in terms of their χ^2 per degree of freedom).

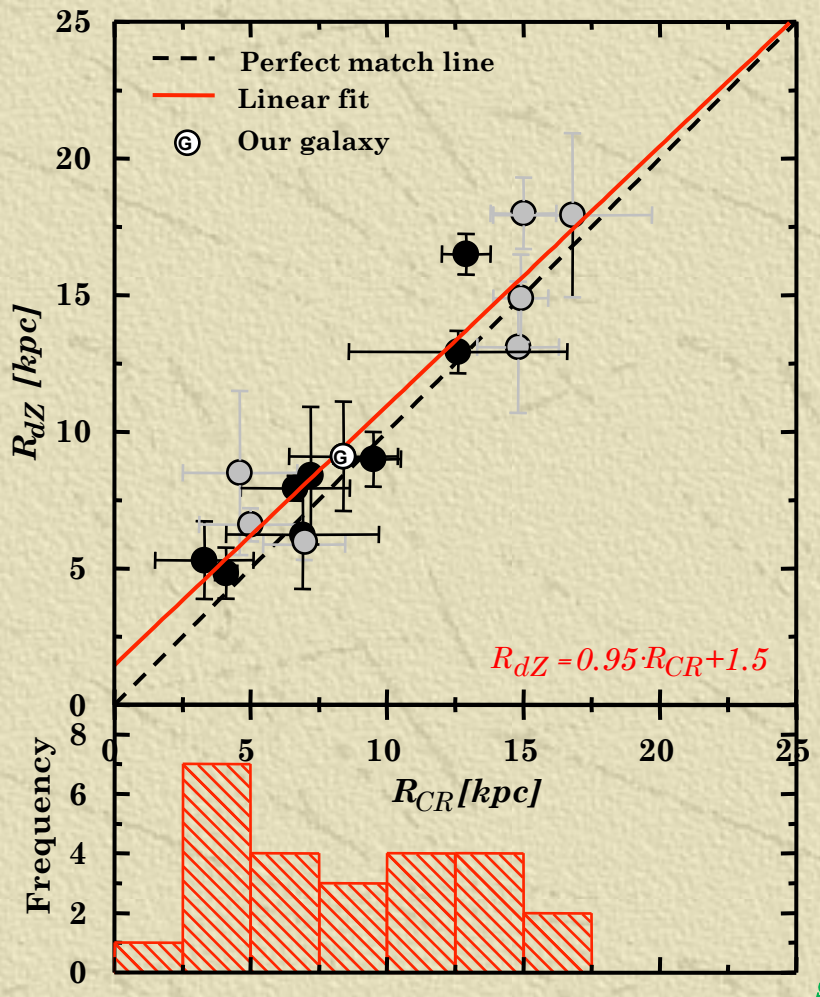


Rozas (2008)

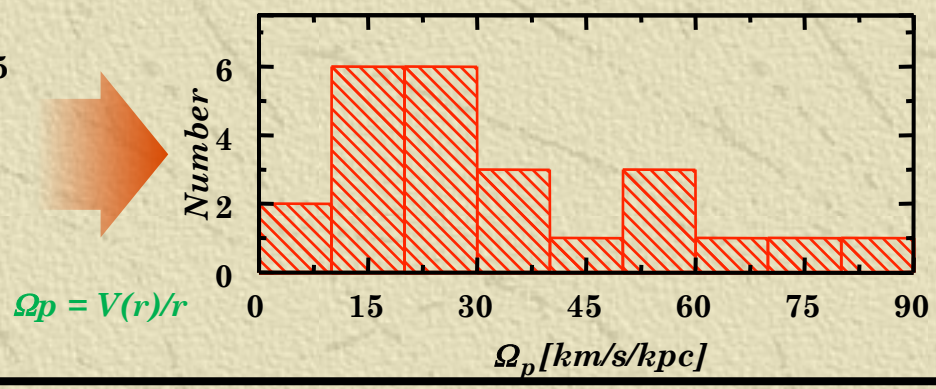
Jensen et al. (1981), Talbot (1980)

Correlation Between the Corotation Radii and Metalicity Breaks Radii

Ploting the breaks in the metallicity distribution radii (R_{dZ}) against the corotation radii (R_{CR}) found in the literature:



- Black point: breaks derived from different calibrations (n_{HII} >> 16 - Dutil & Roy (2001));
- Grey points: galaxies 10 < n_{HII} < 16);
- Data discarded: n_{HII} < 16 or with corotation out of the radial metallicity distribution;
- Match similar if only black points were considered;
- R_{CR} histogram do not reveals preferencial scale, even with normilized with R25;
- Ω_p histogram revels slight preference for values around 25 km/s/kpc.



Thank you!!!