Rotational evolution of low-mass stars at different metallicities

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Context

Open clusters have been extensively studied together, however :

- Do they all have the same **chemical composition** ?
- How does that impact their respective **rotational evolution** ?
- What is the spread we should expect ?

Method

- We used open clusters rotational periods observations
- Their distributions in **metallicity** (Netopil+2016 : ± 0.3 dex around the solar value)
- Internal spread very weak (Bovy (2016) : ~0.02 dex)
- Use of a **grid of evolutionary models** including a self consistent treatment of **rotation** (Amard+18?)

Results

If **Metallicity** increases :

- Opacity ↗
- Convective region size ↗
- Convective turnover time ↗
- Rossby number ↘
- Torque ↗↗

But also :

- Evolutionary timescale ↗
- Radius ↗
- Rotational timescale ↘
- Angular velocity ↘↘

Parameters of the grid

7 Metallicities :

[Fe/H] = -1.0; -0.5; -0.3; -0.15; 0.0; +0.15; +0.3

19 masses :

0.1 $M_\odot$ steps for **M = 0.2 - 0.7 $M_\odot$**
0.05 $M_\odot$ steps for **M = 0.7 - 1.3 $M_\odot$**
0.1 $M_\odot$ steps for **M = 1.3 - 1.5 $M_\odot$**

3 initial rotation periods :

$P_{rot,init}$ = 9.1; 4.5; 1.4 days
(Disc-Locking = 5; 5; 2.5Myr)

Rotational transport/mixing :

Zahn (1992), Mathis+2018, Maeder & Zahn (1998)

Magnetic braking :

Matt+2015

Convection :

MLT with α **= 1.973** (Solar calib.)

Chemical mixture :

Asplund et al. (2009)

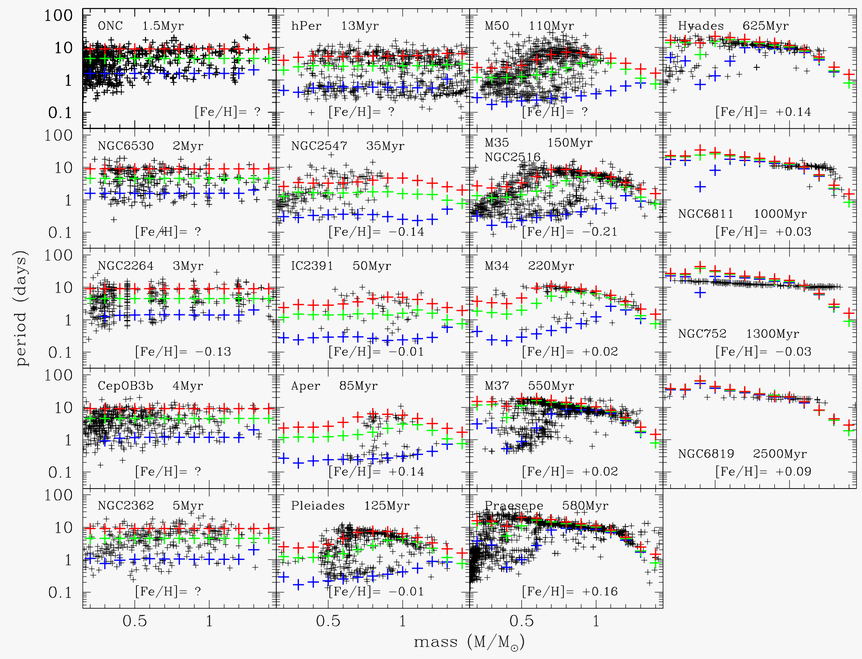
Atmosphere models :

PHOENIX-BT-Settl

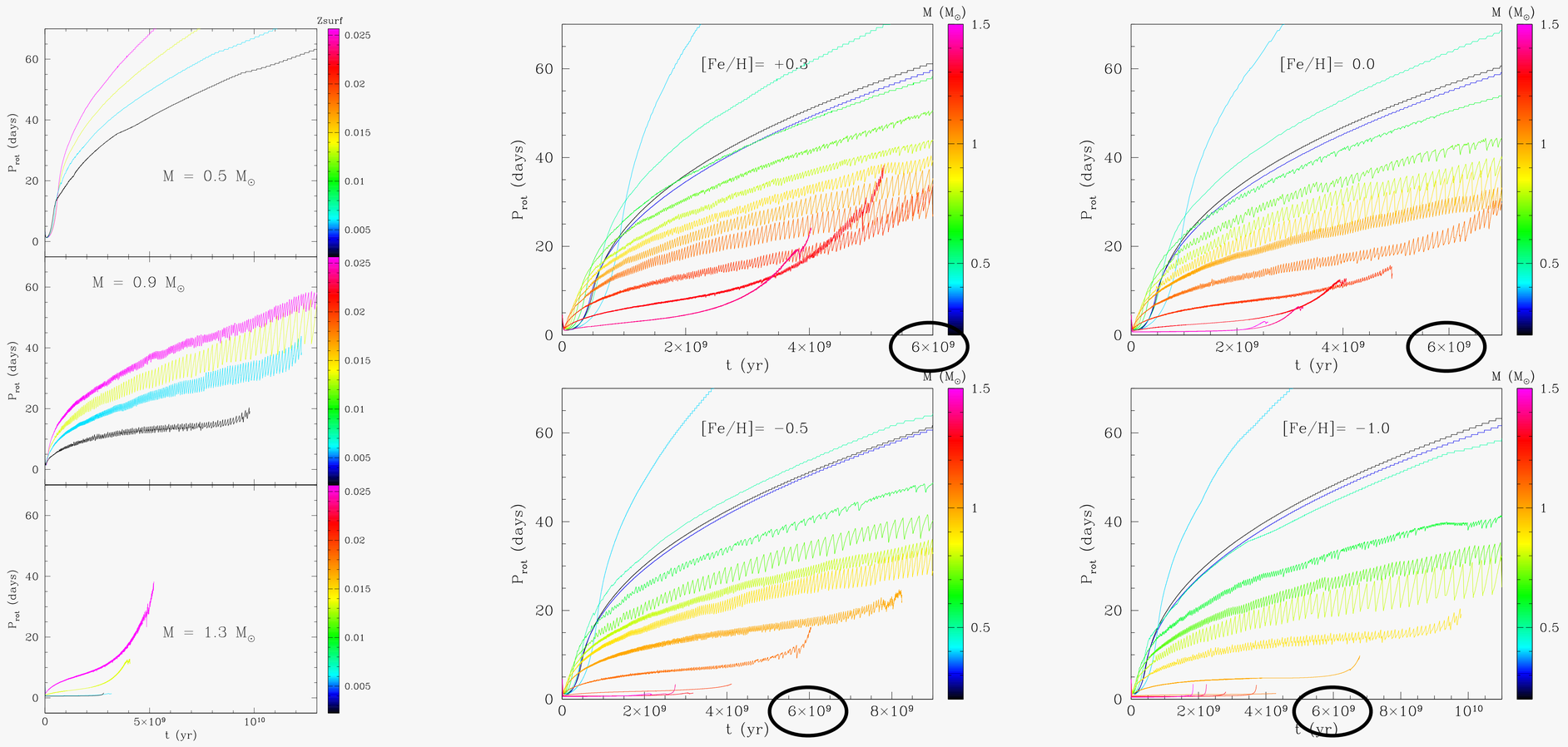
Nuclear network :

Nacre II

Evolution of rotation



Metallicity



Conclusion

1) Rotational evolution is strongly dependent of metallicity
2) A higher metallicity is leading to a more important torque and so a quicker rotational evolution
3) We should expect a certain spread if ones expect to reproduce all clusters
4) Application to the Kepler field and use on Gaia data
5) Urgent need for consistent redeterminations of stellar (cluster) ages and masses

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