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Connecting the disk dispersal phase to magnetic morphology-driven stellar spin down

Kristina Monsch[1], Jeremy J. Drake[1], Cecilia Garraffo[1], Giovanni Picogna[2], Barbara Ercolano[2,3]

[1] Harvard-Smithsonian Center for Astrophysics; [2] Universitäts-Sternwarte, Ludwig-Maximilians-Universität München; [3] Excellence Cluster Origin and Structure of the Universe

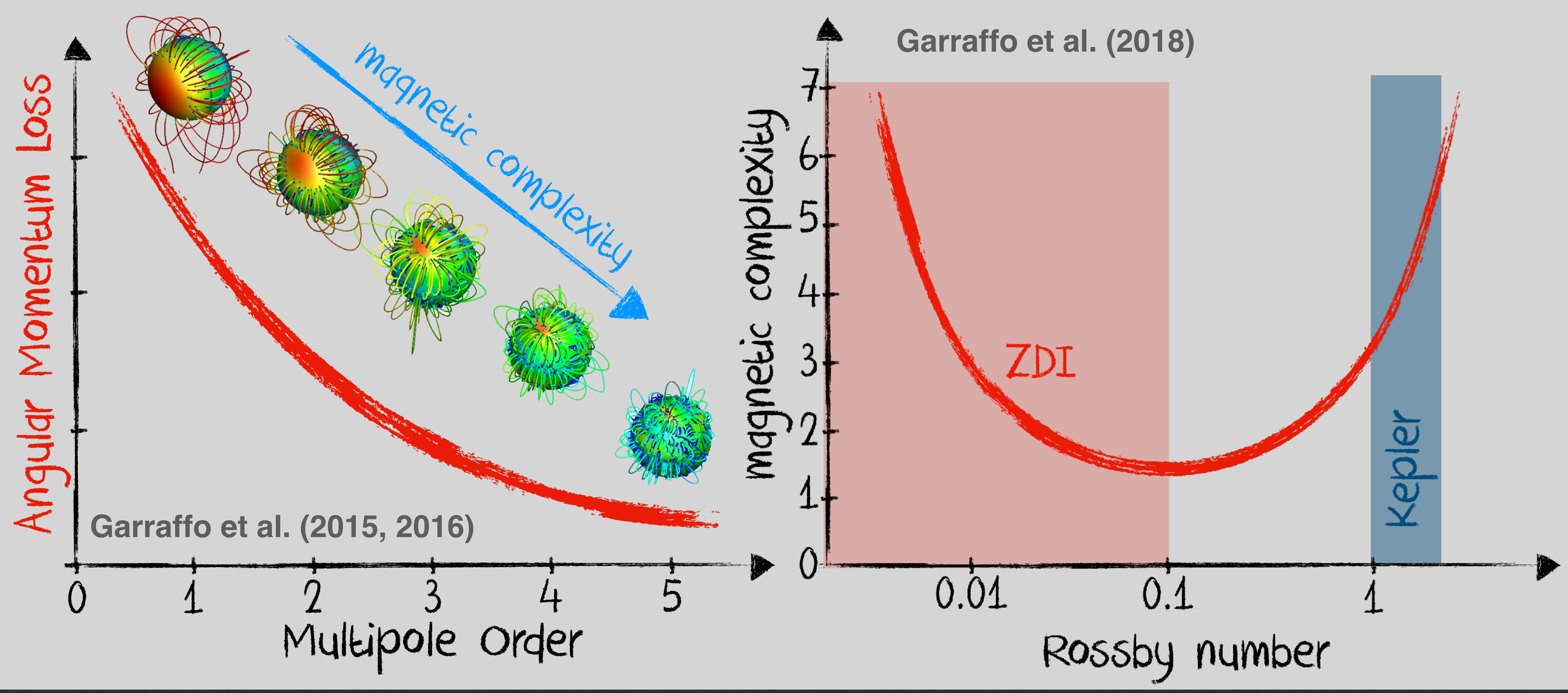
Any more questions? Contact me at kristina.monsch@cfa.harvard.edu

The lifetimes of a planet-forming disks can have a strong impact on the subsequent rotational evolution of their young host stars. To this aim, we present a model to include realistic disk lifetimes into a rotational evolution model of solar-type stars, ultimately enabling us to predict the long-term evolution of the stellar high-energy (UV/X-ray) emission.

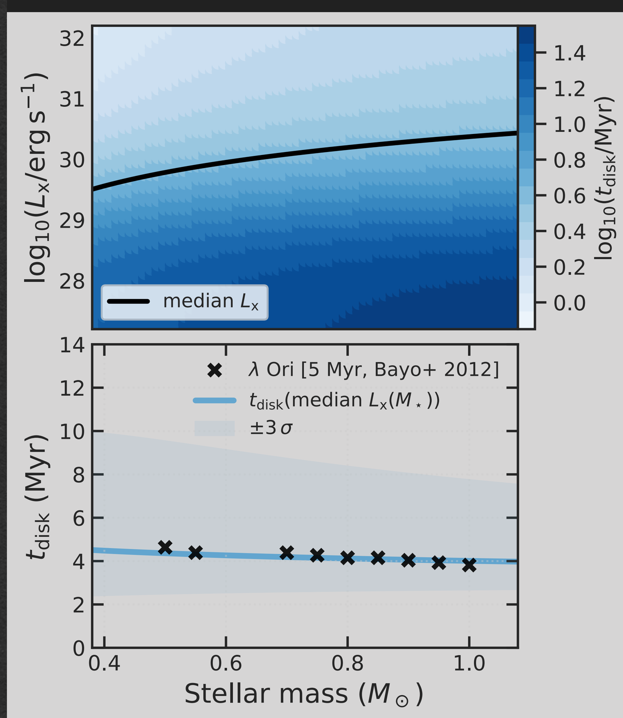
Short on time? Look at my online poster!

Magnetic activity of cool stars

Stellar rotation fuels magnetic activity through dynamo action and, in turn, activity controls spin-down rates. This self-regulating mechanism results in a relationship between the stellar rotation period and mass that evolves with time. Zeeman–Doppler-Imaging (ZDI) observations suggest that young, active stars store a larger fraction of their magnetic flux in higher-order multipoles. This complexity decreases with increasing rotation period (or the dimensionless Rossby number $Ro = P_{\rm rot}/\tau_c$). On the other hand, *Kepler* observations show a deviation from gyrochronology at $Ro \approx 1-2$ (i.e. slowly rotating stars), which could correspond to a new increase of complexity. The magnetic field complexity dramatically reduces the stellar angular momentum loss rates by several orders of magnitude, meaning stars with higher-order magnetic fields lose angular momentum less efficiently and thus spin down slower.



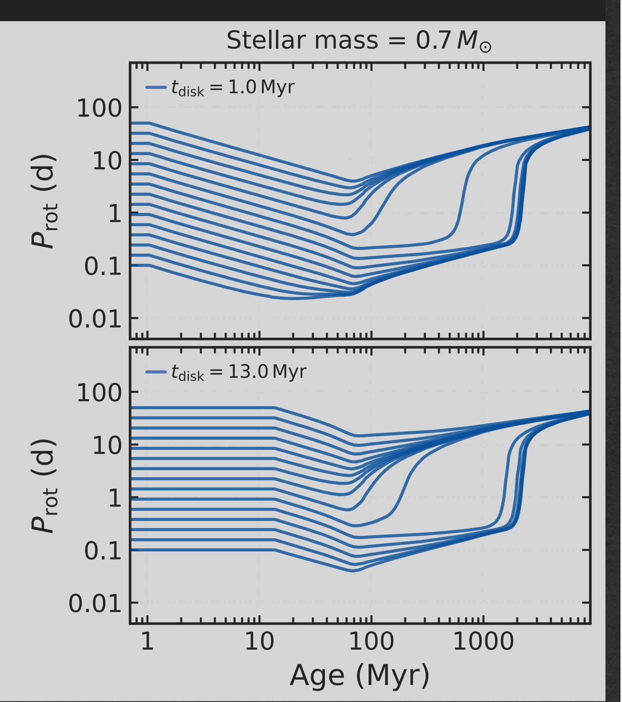
Calculating disk lifetimes



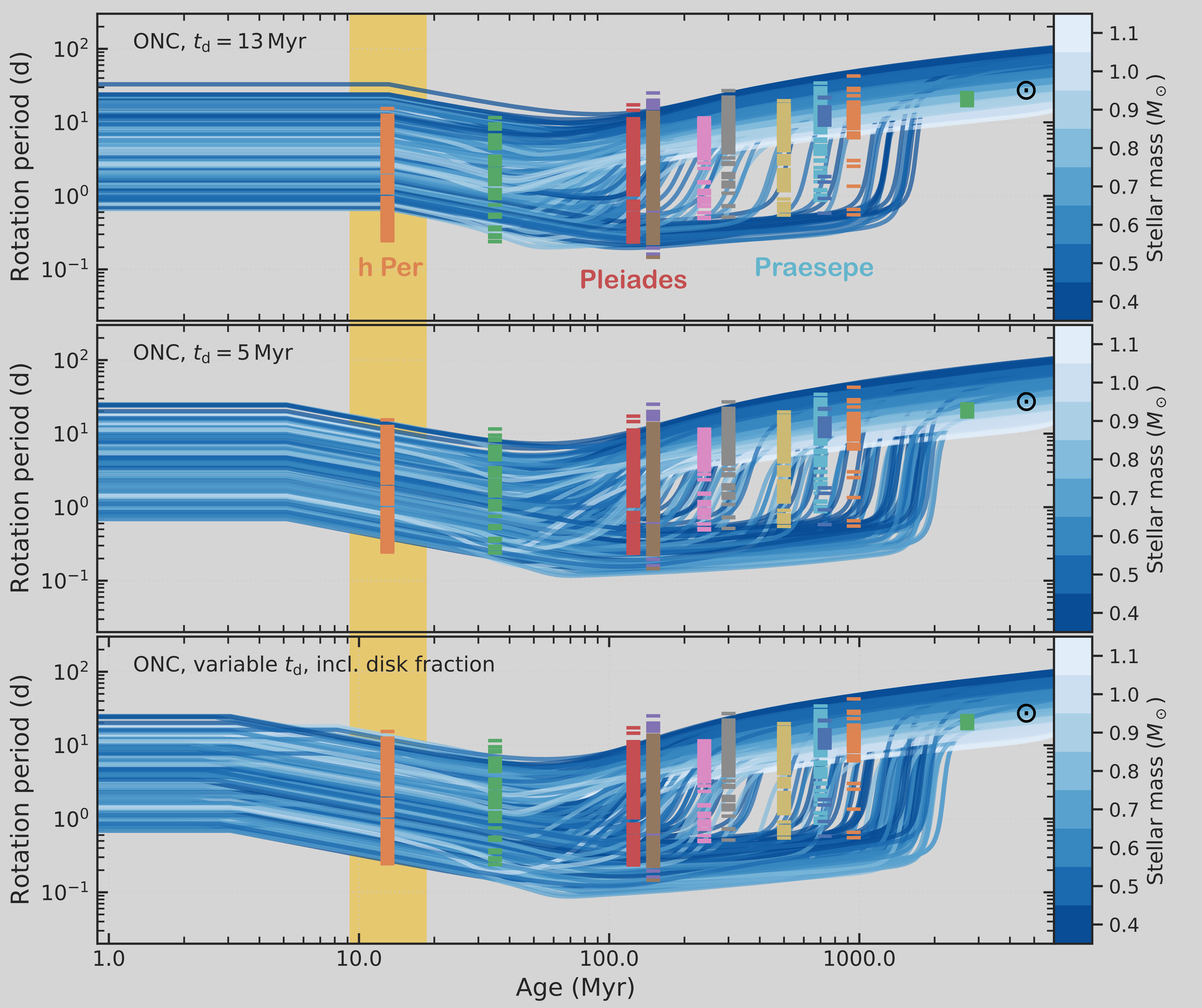
1. mainly determined by viscous evolution and internal photoevaporation driven by the host star
2. calculated using the internal EUV+X-ray photoevaporation model by Picogna et al. (2019, 2021) & Ercolano et al. (2021)
3. can be ultimately determined using only 2 parameters: the stellar mass & X-ray luminosity

Rotational evolution model

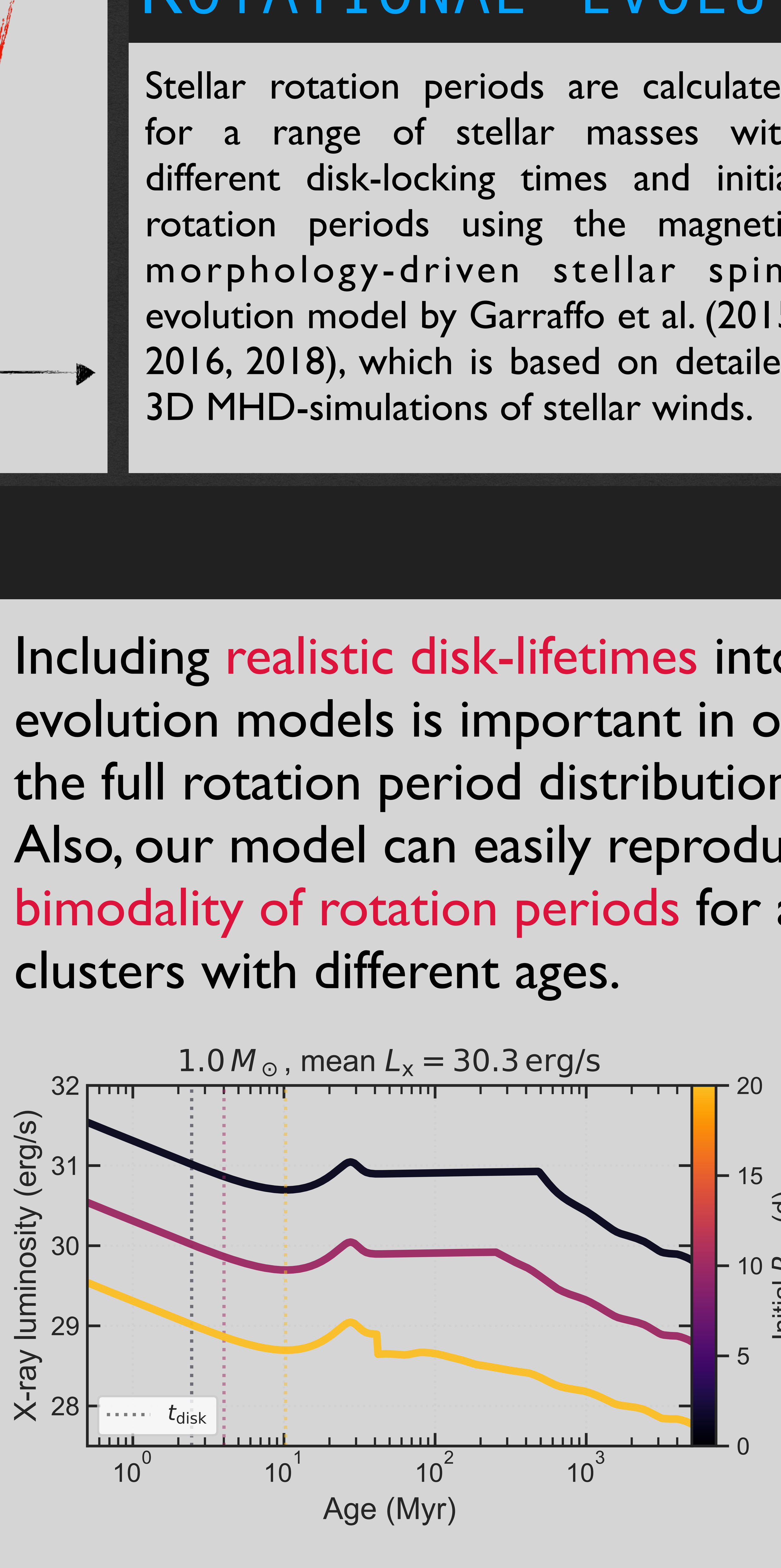
Stellar rotation periods are calculated for a range of stellar masses with different disk-locking times and initial rotation periods using the magnetic morphology-driven stellar spin-evolution model by Garraffo et al. (2015, 2016, 2018), which is based on detailed 3D MHD-simulations of stellar winds.



Results



Including realistic disk-lifetimes into rotational evolution models is important in order to recover the full rotation period distribution of h Persei. Also, our model can easily reproduce the observed bimodality of rotation periods for a range of open clusters with different ages.



Next steps: Model the long-term evolution of the stellar high energy (X-ray/UV) emission using the rotation-activity relation (e.g. Wright et al. 2018).