

Pre-Main Sequence of Low Mass Stars - II

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MESA Summer School 2013

I

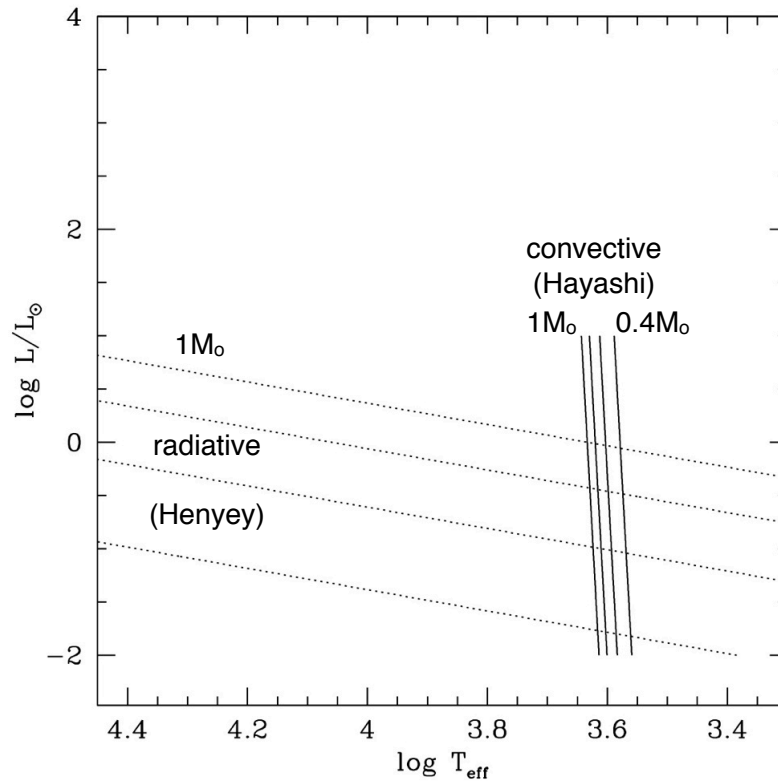
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‘Initial’ conditions

- what I won’t talk about (much) but that does matter
 - initial collapse (see Palla & Stahler)
 - magnetic fields
 - disks / jets
- where we’ll start
 - uniform composition
 - cool enough for no nuclear energy/transformation
 - spherical
 - non-magnetic, some rotation

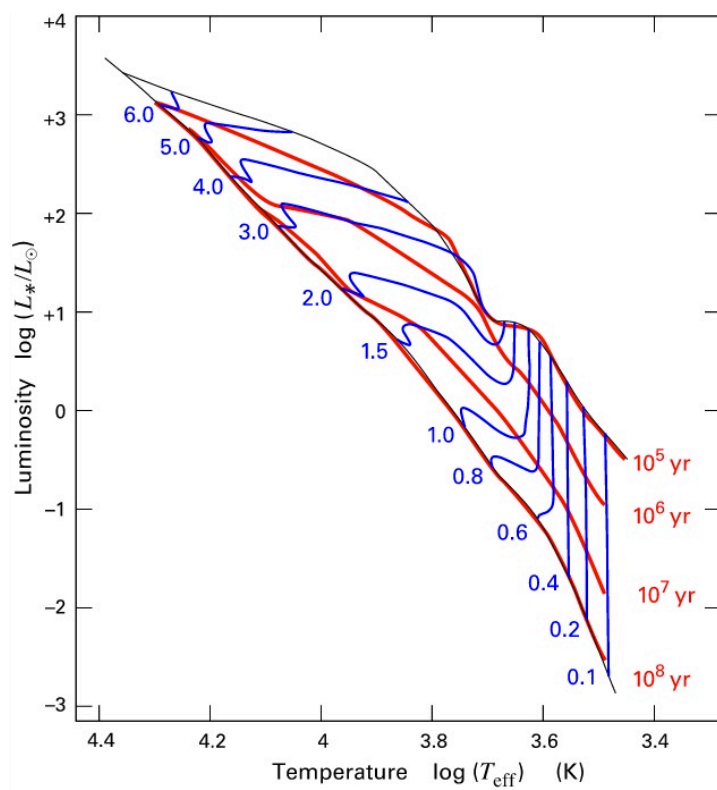
convective and radiative tracks

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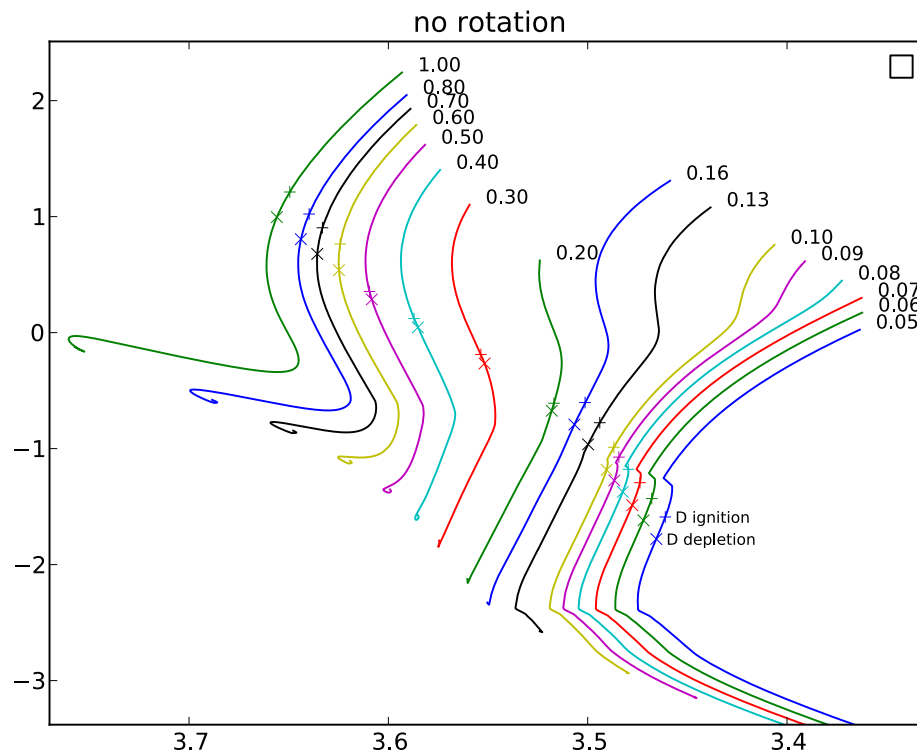
Evolutionary tracks / isochrones

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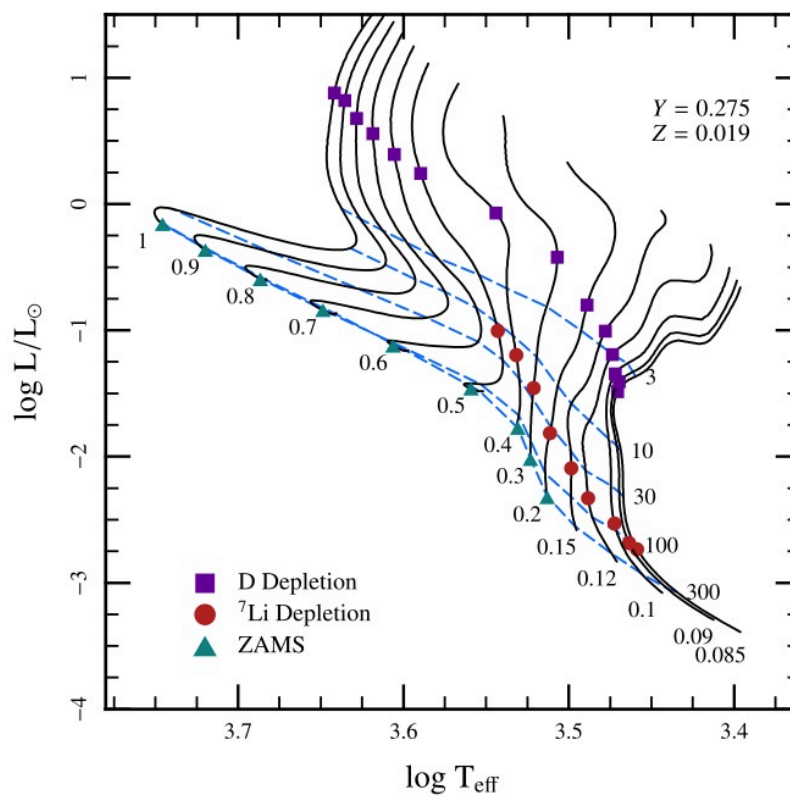


from Stahler & Palla
(2008)

log L vs. T_{eff}

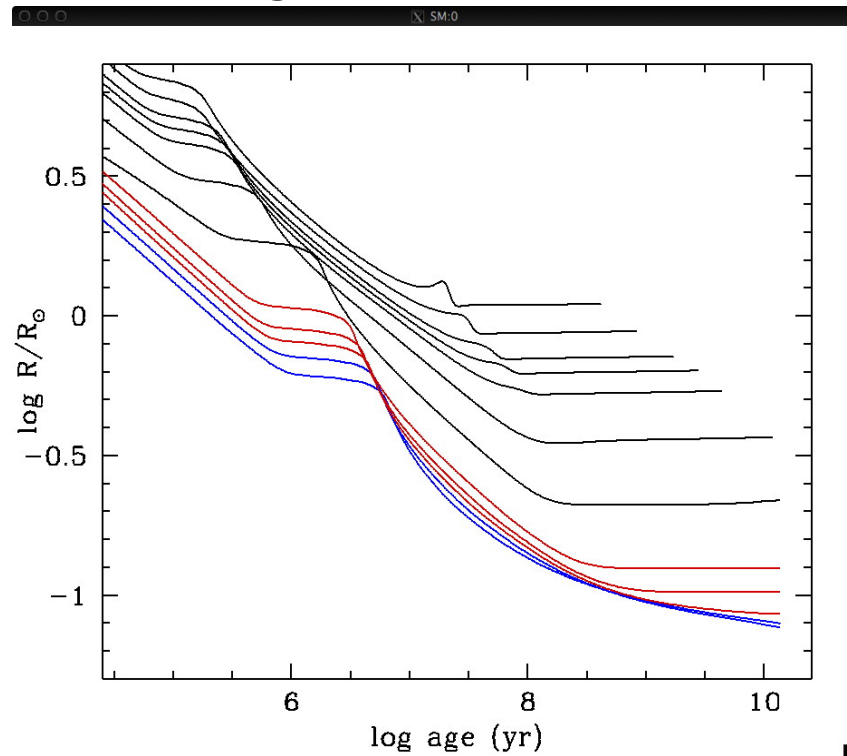


MESA Evolutionary tracks / isochrones

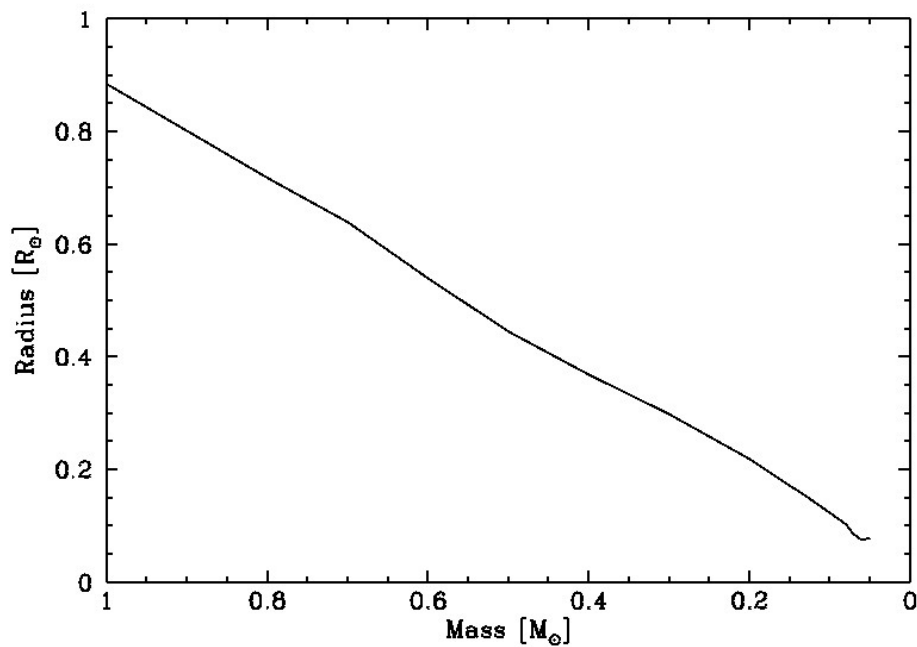


MESA

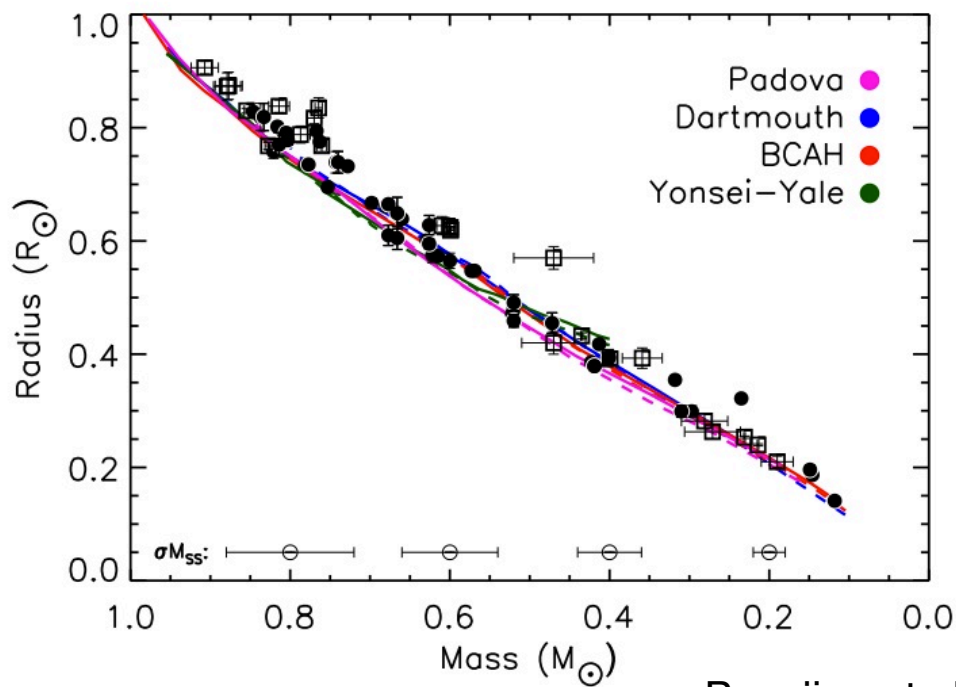
log R vs time



M-R relation, models

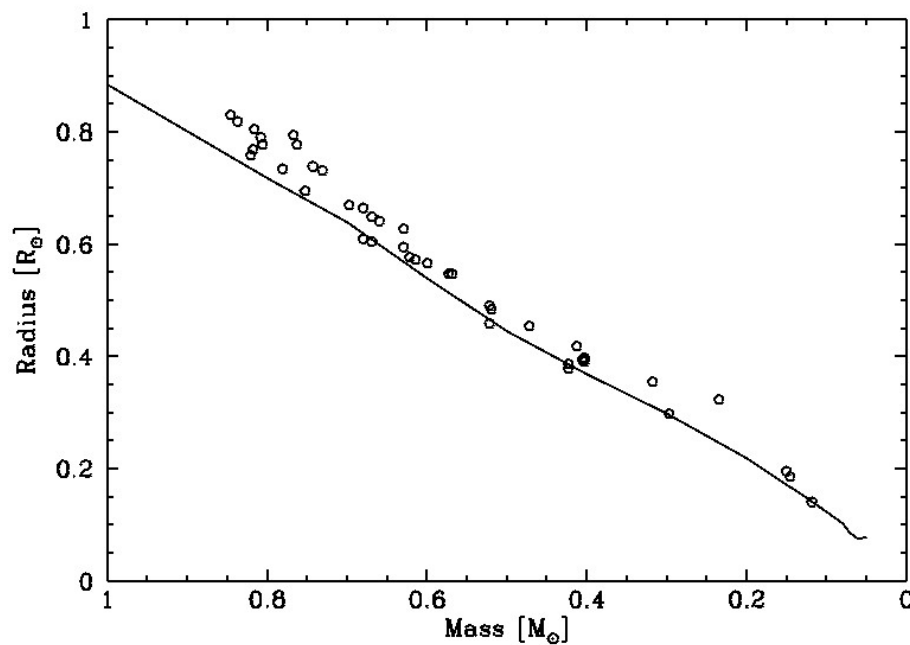


observed MS M-R relation



Boyajian et al. 2012

observed MS M-R relation



Boyajian et al. 2012

Lab 2, part 1 - the M-R relation of lower MS

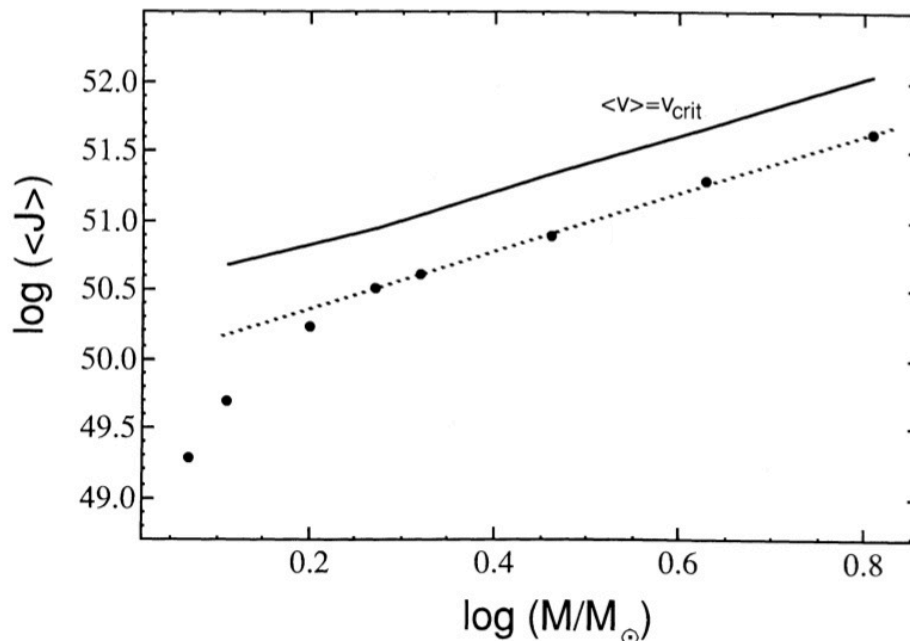
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1. **mass you should do = $0.2 \times \text{birthdate mod } 5$**
2. Evolve from PMS to \sim ZAMS and find $R(M)$ for
 - 2.1. same conditions as Monday (you did keep those models, right?)
 - 2.2. different **boundary conditions**:
`which_atm_option = 'tau_100_tables'`
 - 2.3. different **mixing length**:
change from $\alpha = 2.0$ (default) to 2.2 (and/or to 1.5)
3. Data from Boyadjian is available in *work_pms_lab2a*
- compare your results with the data.
 - 3.1. for a given M , how far off is R ?
 - 3.2. which is a bigger effect, OBCs or mixing length? What about age?
4. **BONUS** - compute a ZAMS model with the same mass and parameters and see if its radius the same as the PMS model evolved *to* the ZAMS
5. email your model results to Chris (cmankovich@ucsc.edu):
 - 5.1. ascii file with M , R , and a comment field

PMS Rotation

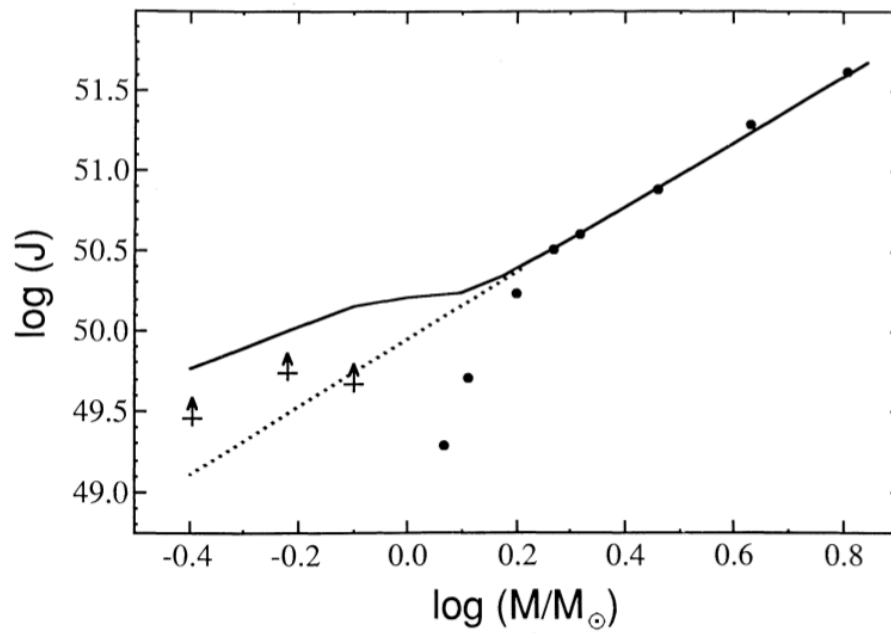
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- the 'Kraft Curve'

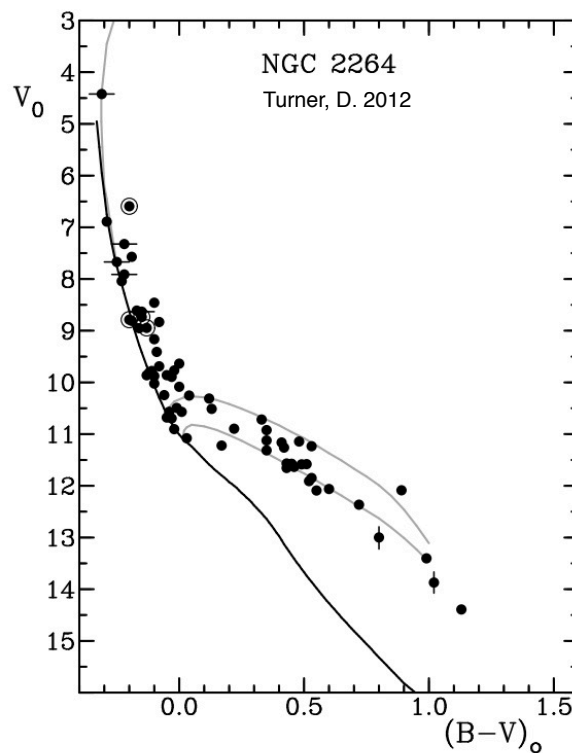


PMS Rotation

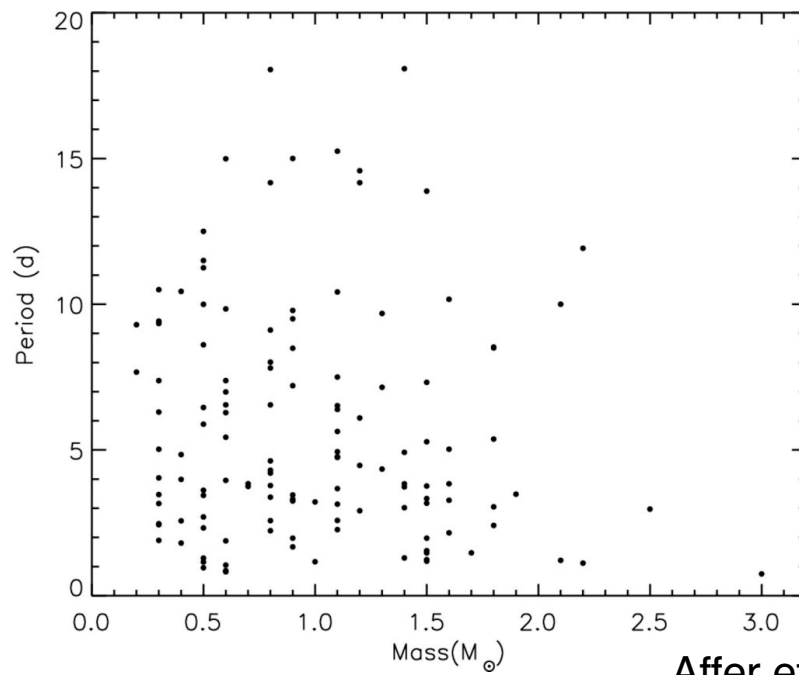
- the 'Kraft Curve' - and backing out initial J



NGC 2264

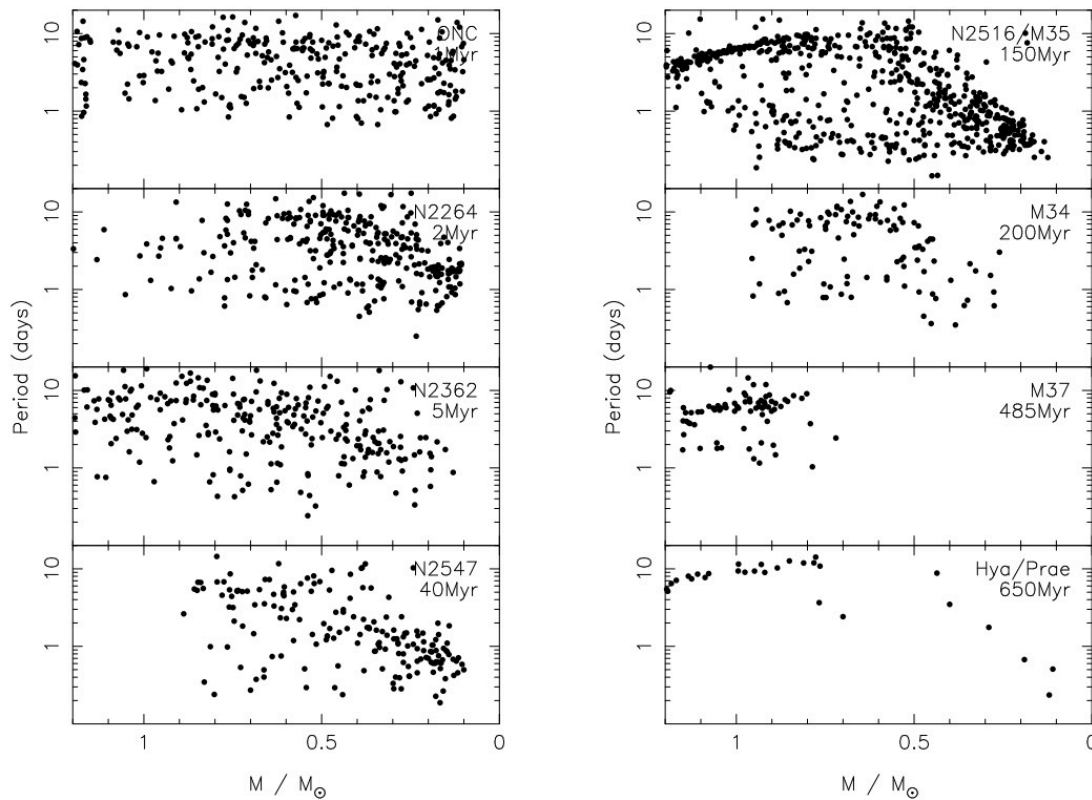


NGC 2264 - rotation



Affer et al. 2013

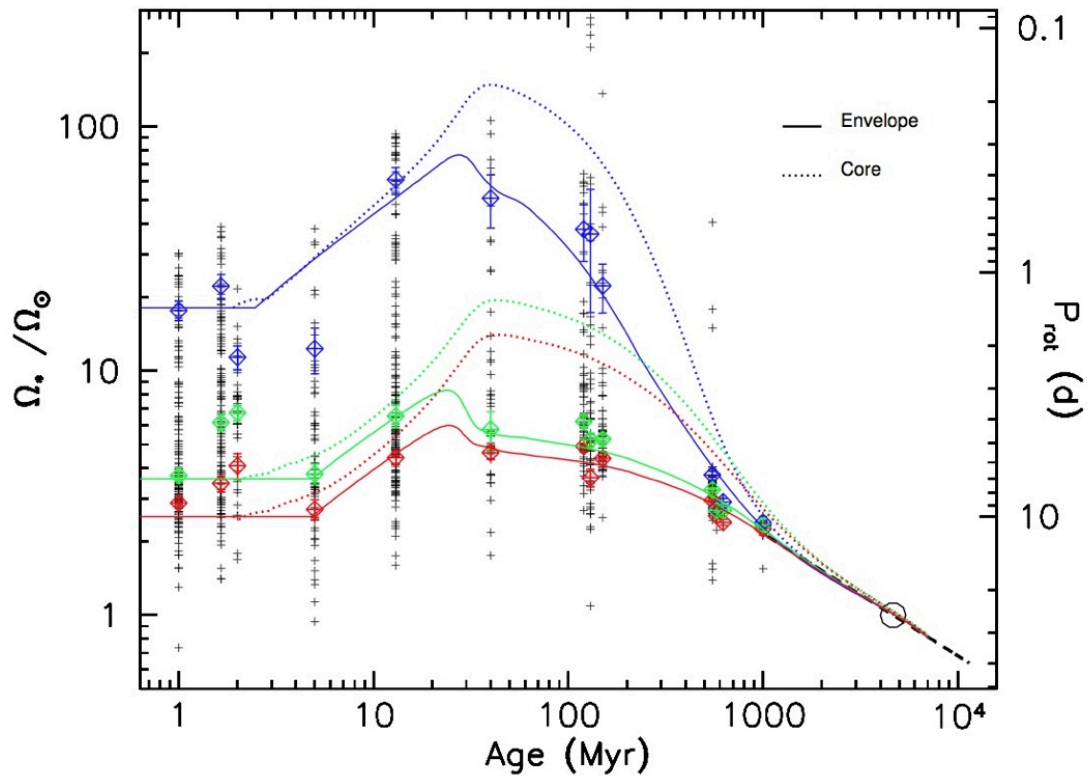
evolution of rotation in low-mass stars



Irwin & Bouvier 2009

evolution of rotation in low-mass stars

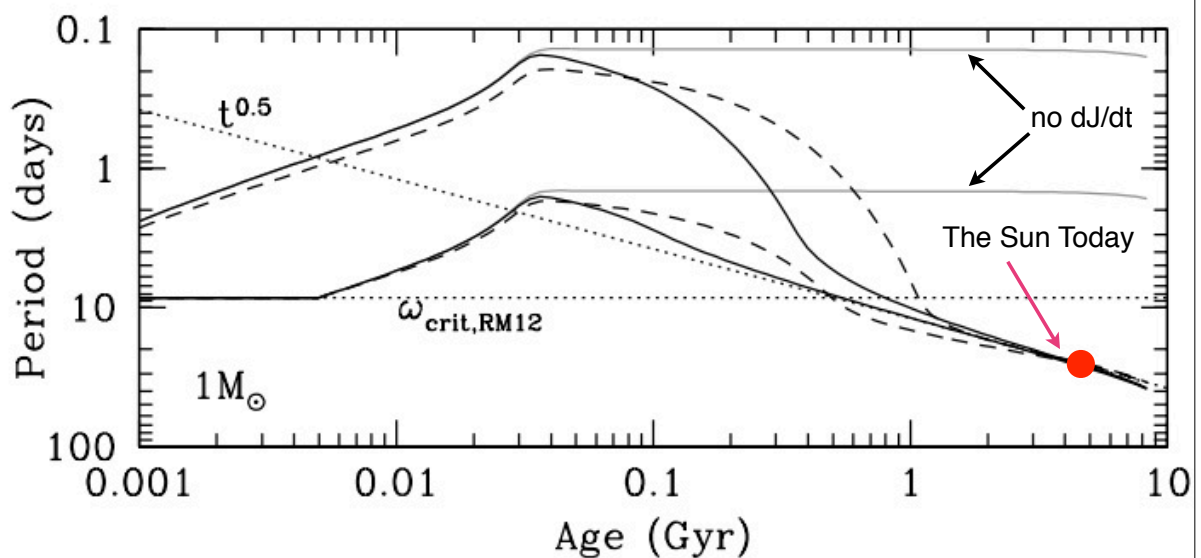
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Gallet & Bouvier 2013

angular momentum loss via magnetized stellar wind

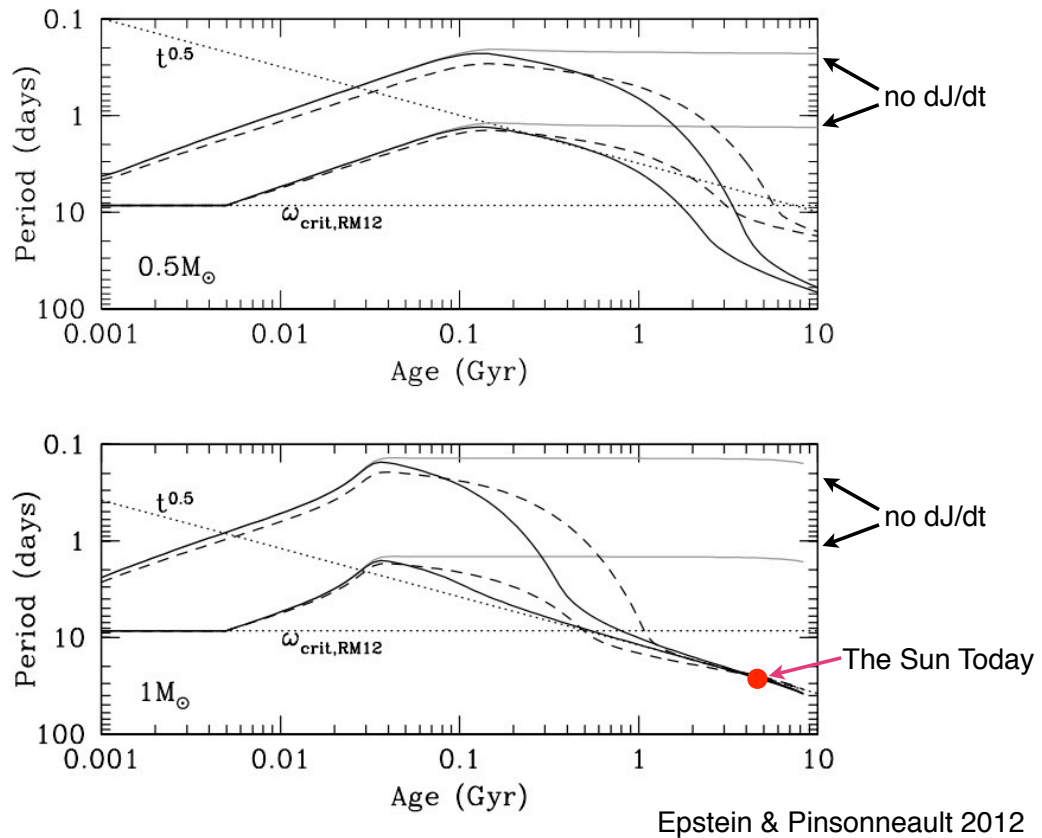
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Epstein & Pinsonneault 2012

evolution of rotation in low-mass stars

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Lab 2, part 2 - rotation and spin-down

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1. **mass** you should do - one or more of **0.8, 1.0, 1.2, 2.0**
2. sample work directory: *work_pms_rotation*
3. create new starting model using *inlist_pms_startrot*
4. evolve using *inlist_pms_rotation*
 - 4.1. use initial rotation velocity specified in comments
 - 4.2. output in LOGS/history.data
5. Plot rotation velocity as a function of time and rotation period vs. time using data from history.data
6. compare with observations of young clusters, the Sun, etc.