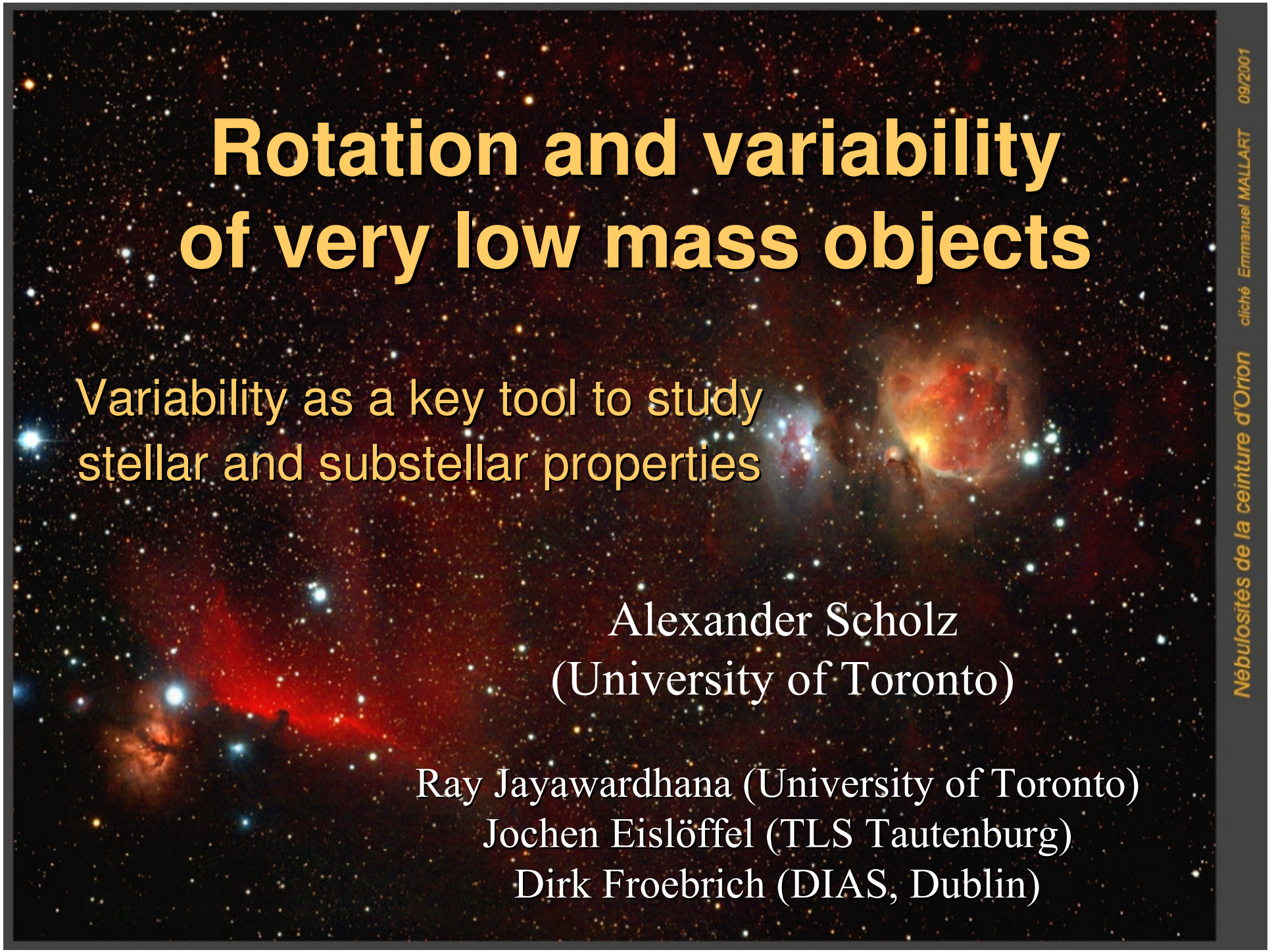


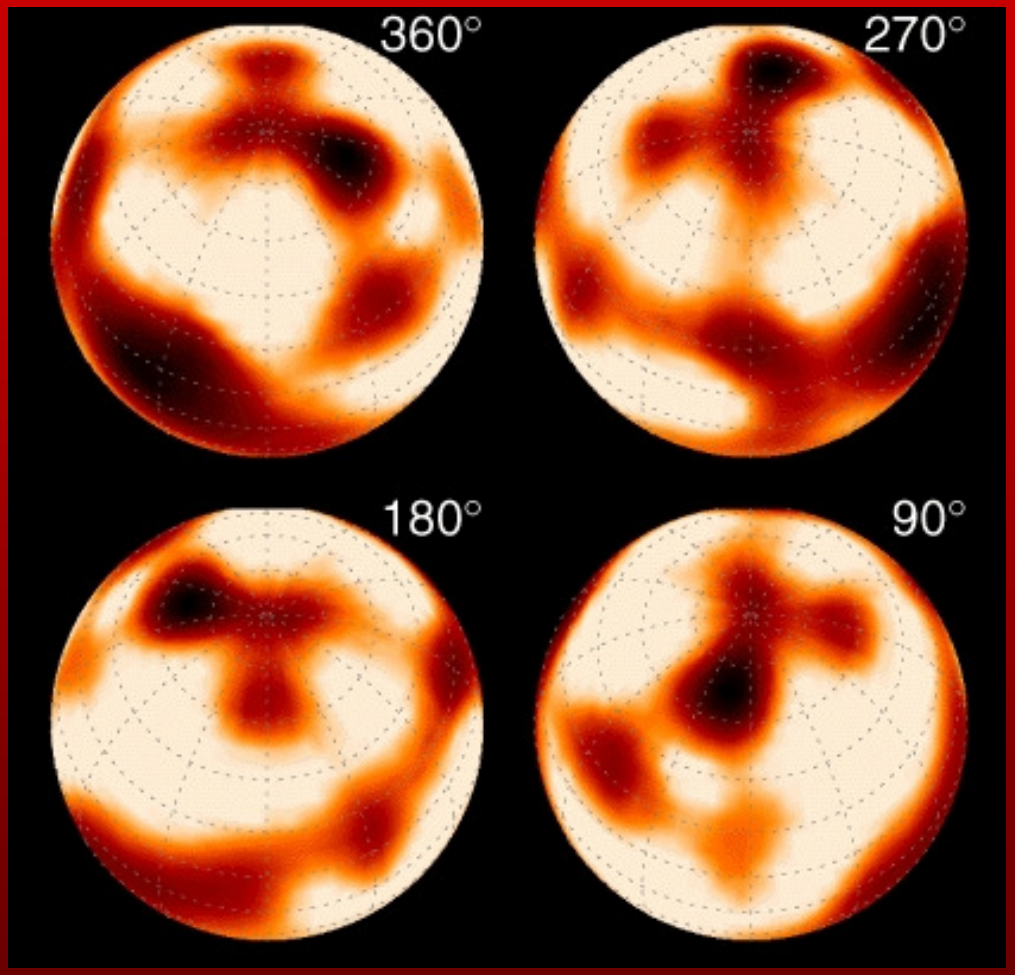
Rotation and variability of very low mass objects

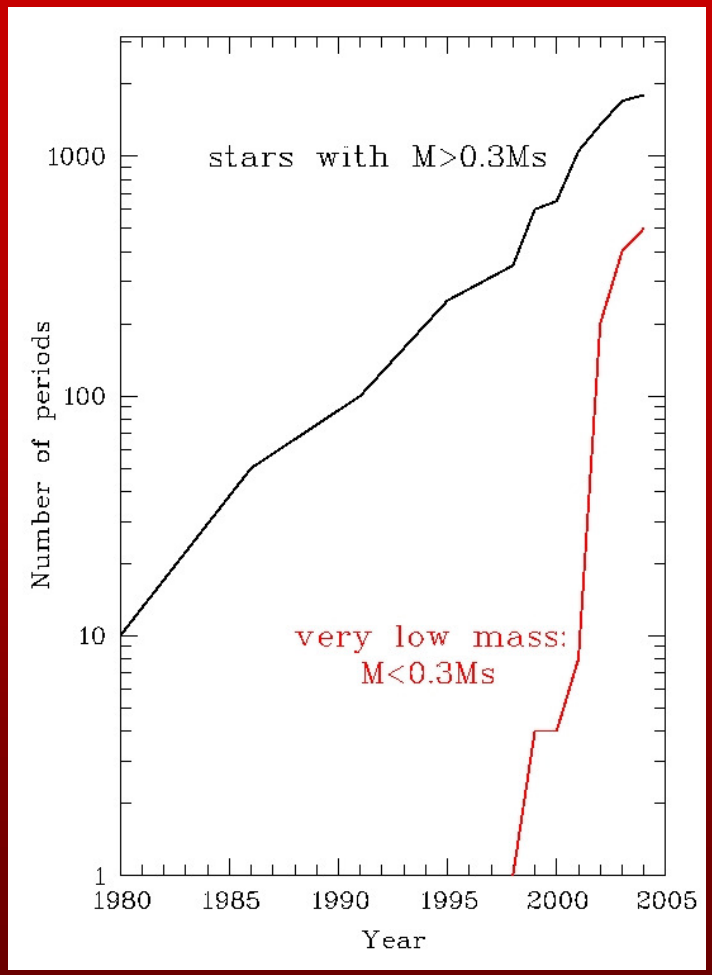
Variability as a key tool to study stellar and substellar properties

Alexander Scholz
(University of Toronto)

Ray Jayawardhana (University of Toronto)
Jochen Eislöffel (TLS Tautenburg)
Dirk Froebrich (DIAS, Dublin)

Photometric rotation periods

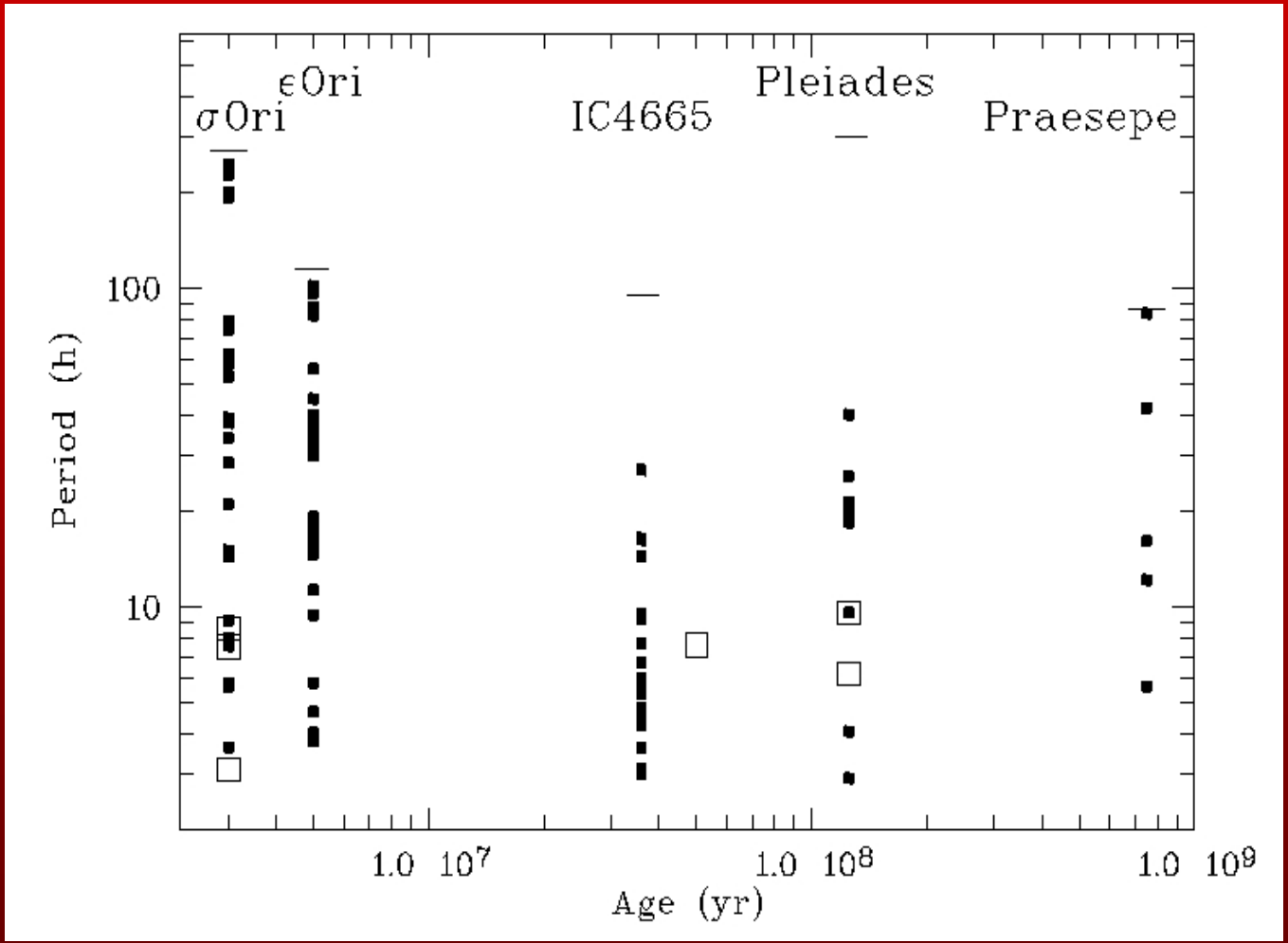




solar-mass stars: ~2000

very low mass objects: ~500

VLM rotation periods

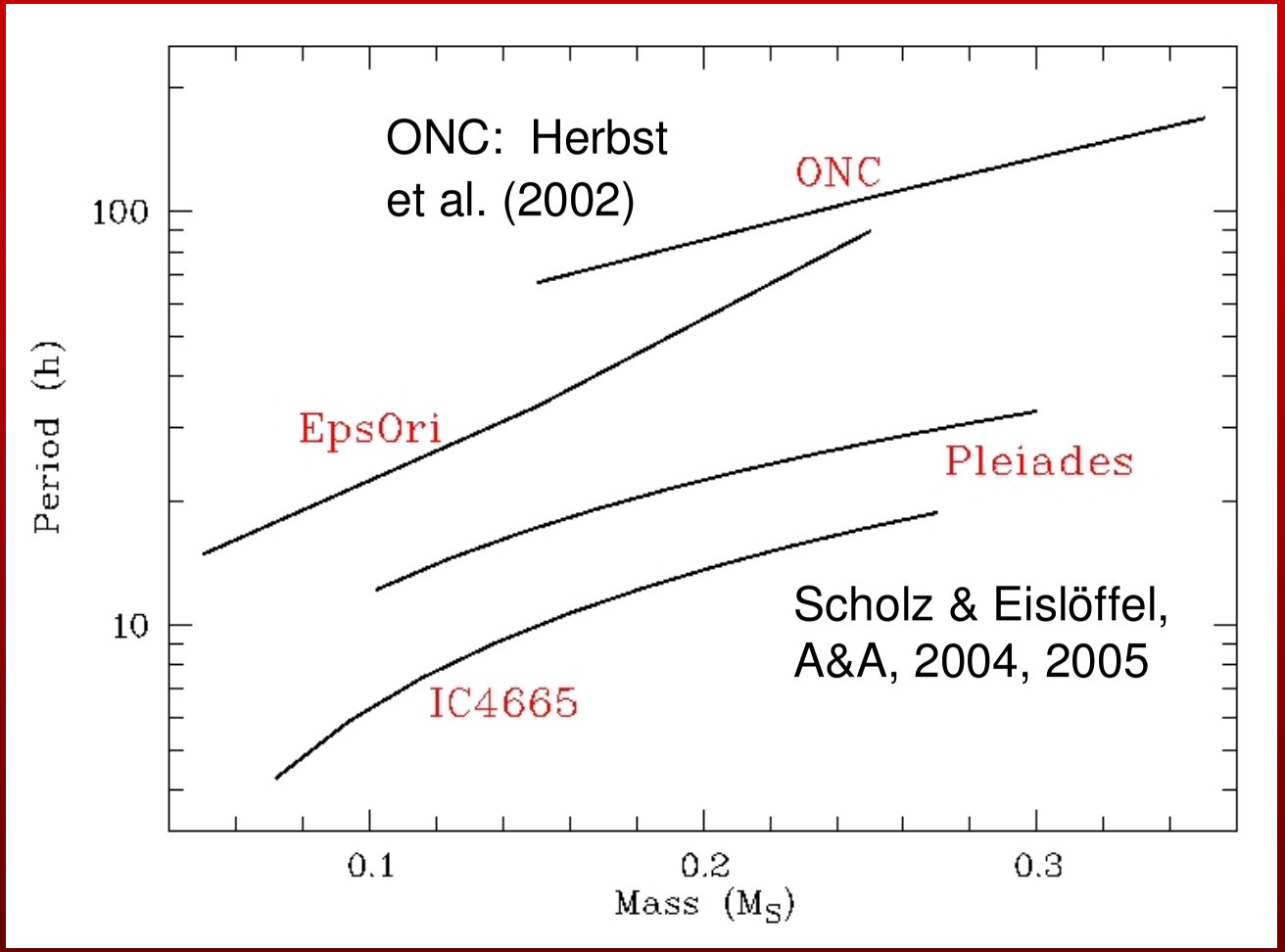


Scholz & Eislöffel:
A&A, 2004, 419, 249
A&A, 2004, 421, 259
A&A, 2005, 429, 1007

PhD thesis A. Scholz

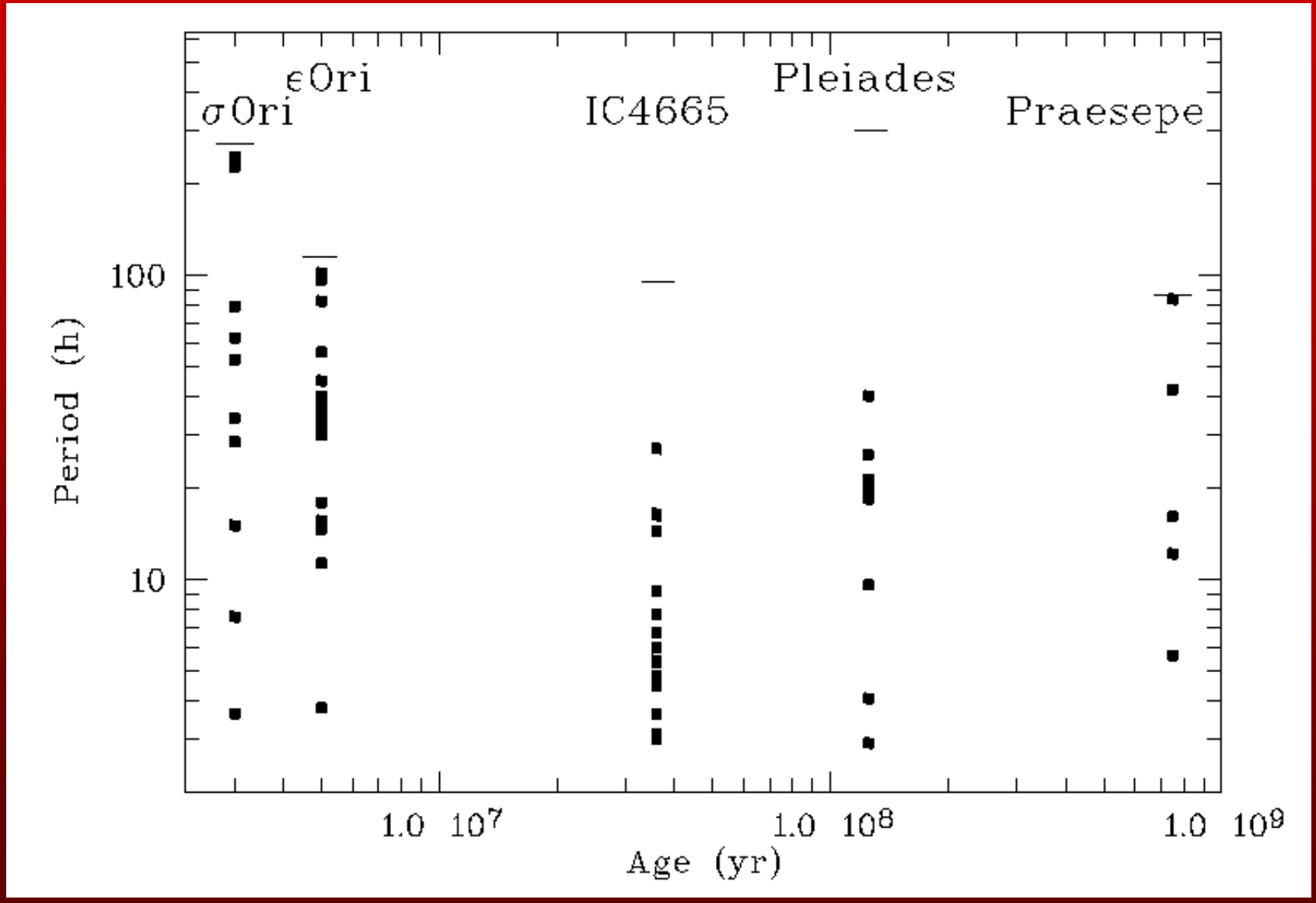
2003: 6 periods (squares) 2004: 80 periods (large dots)

Period vs. Mass

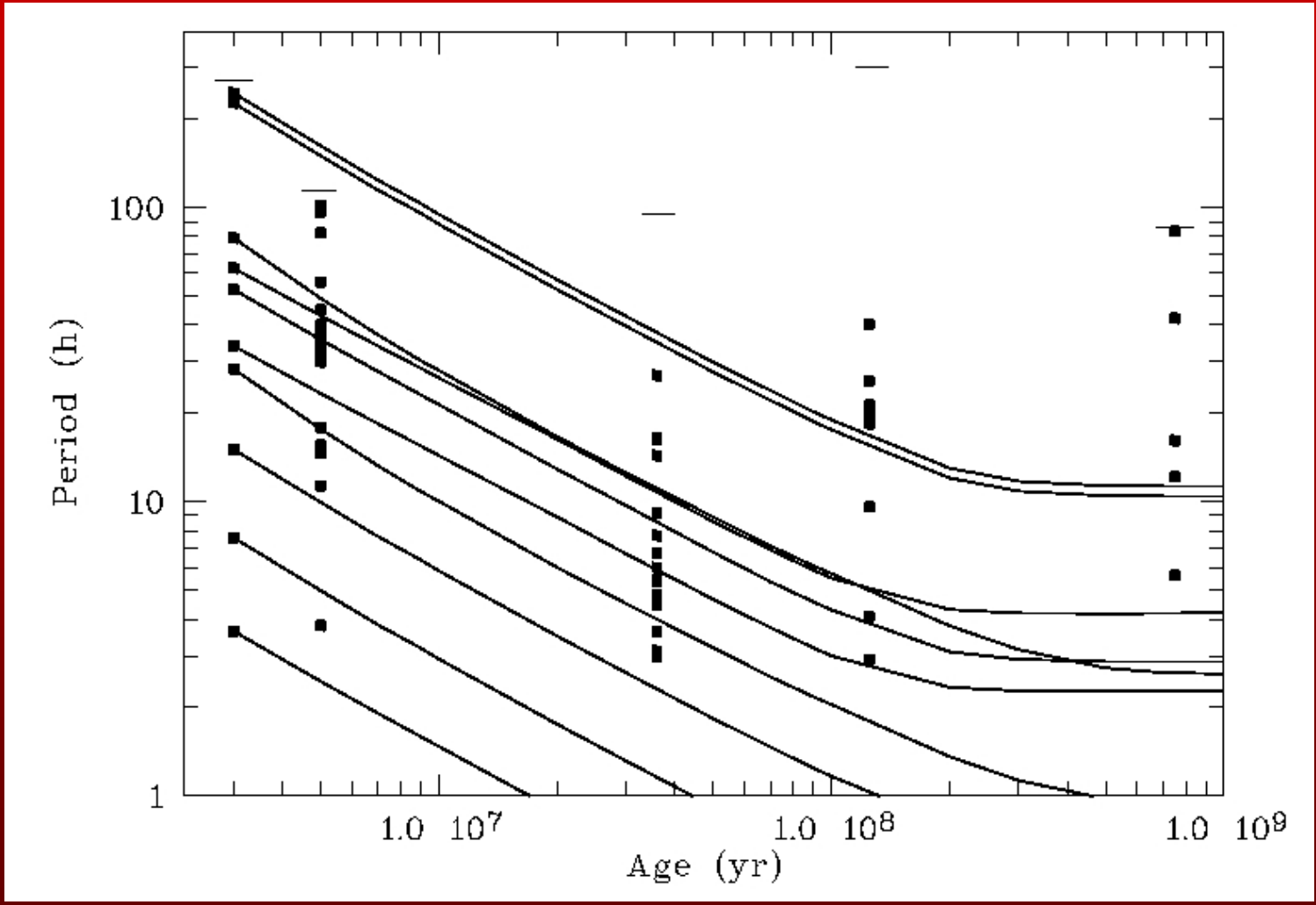


VLM objects rotate faster than solar-mass stars
Average period correlated with mass

Rotational evolution

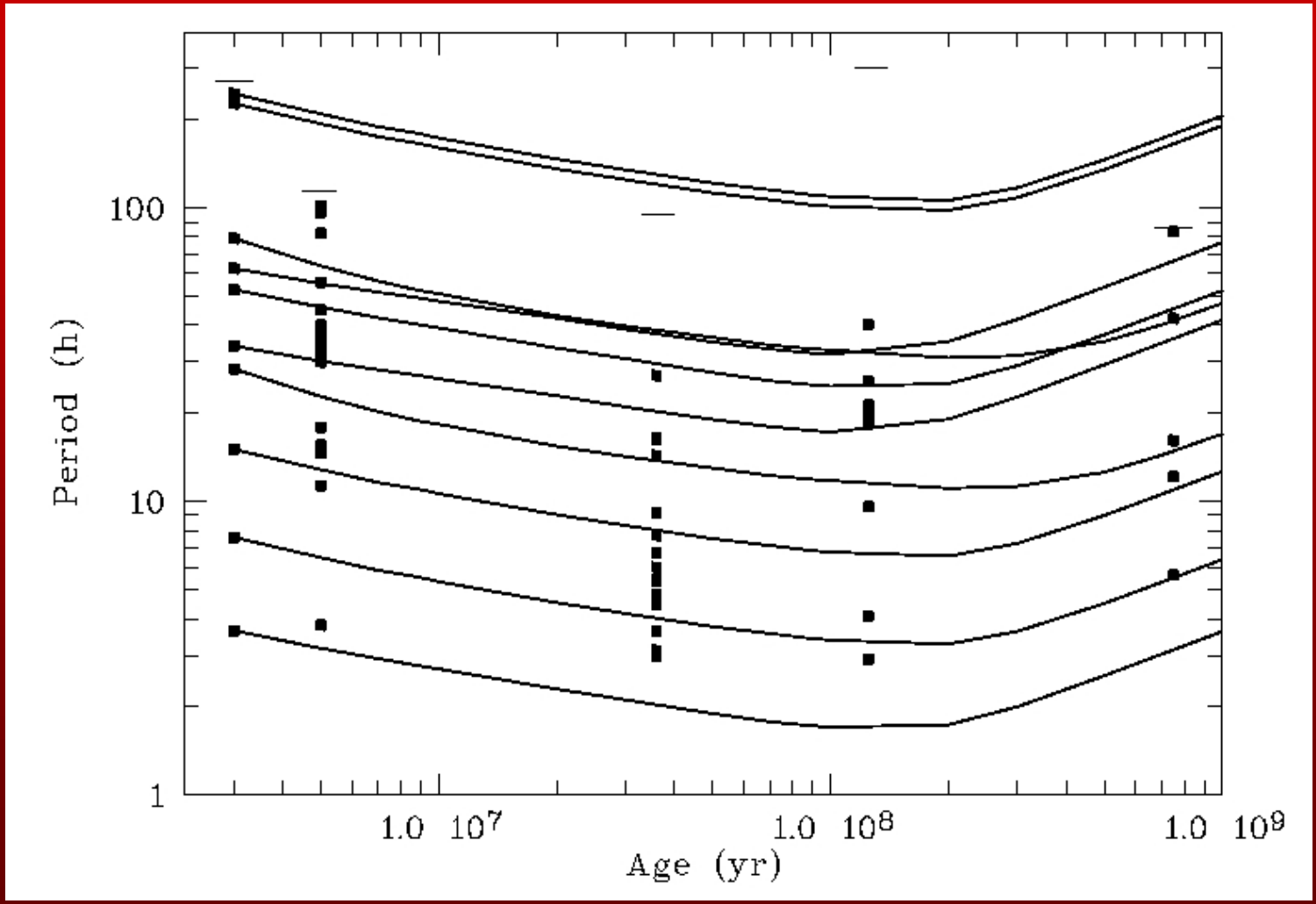


Only contraction



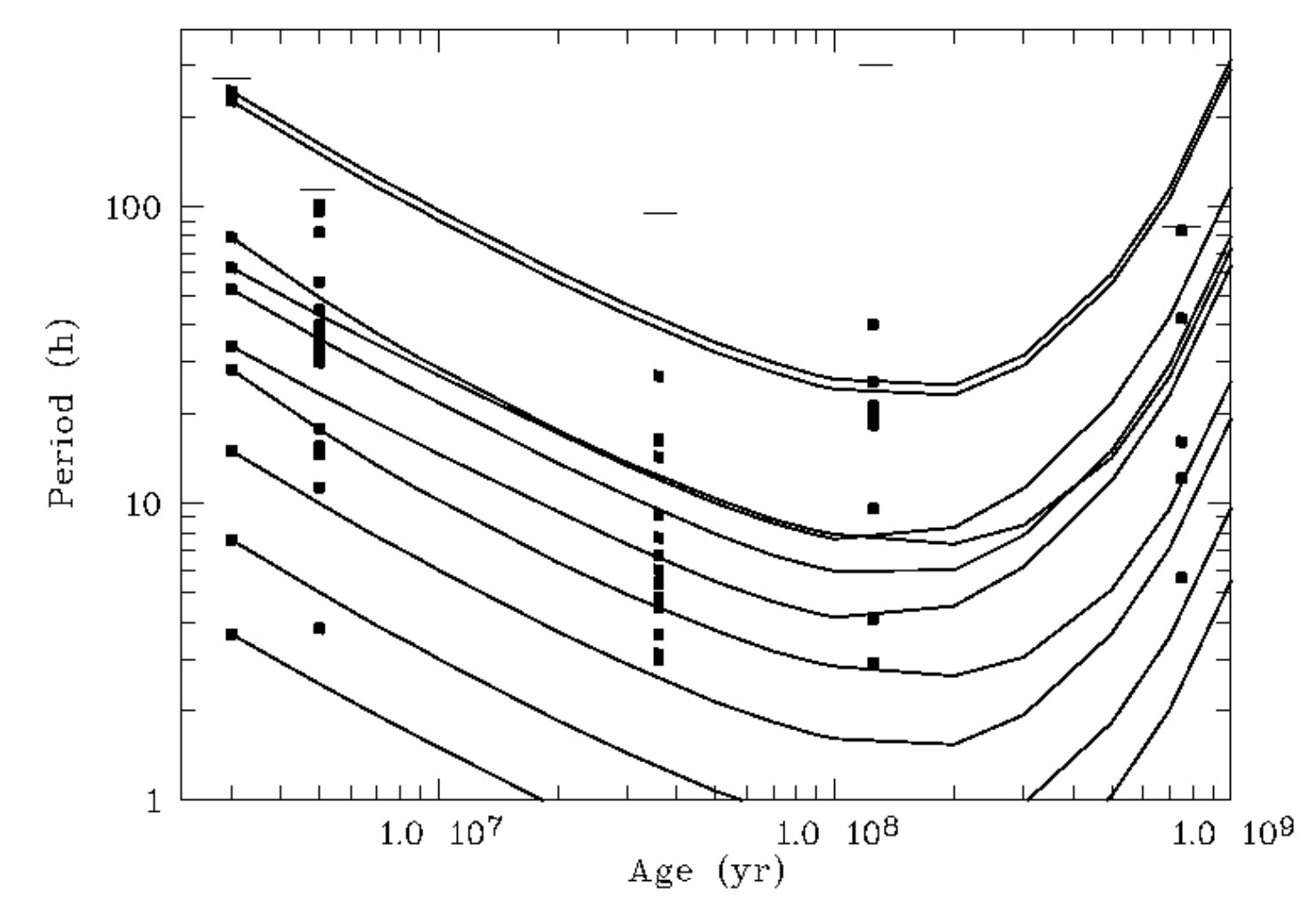
angular momentum loss necessary to explain slow rotators

Contraction + Skumanich



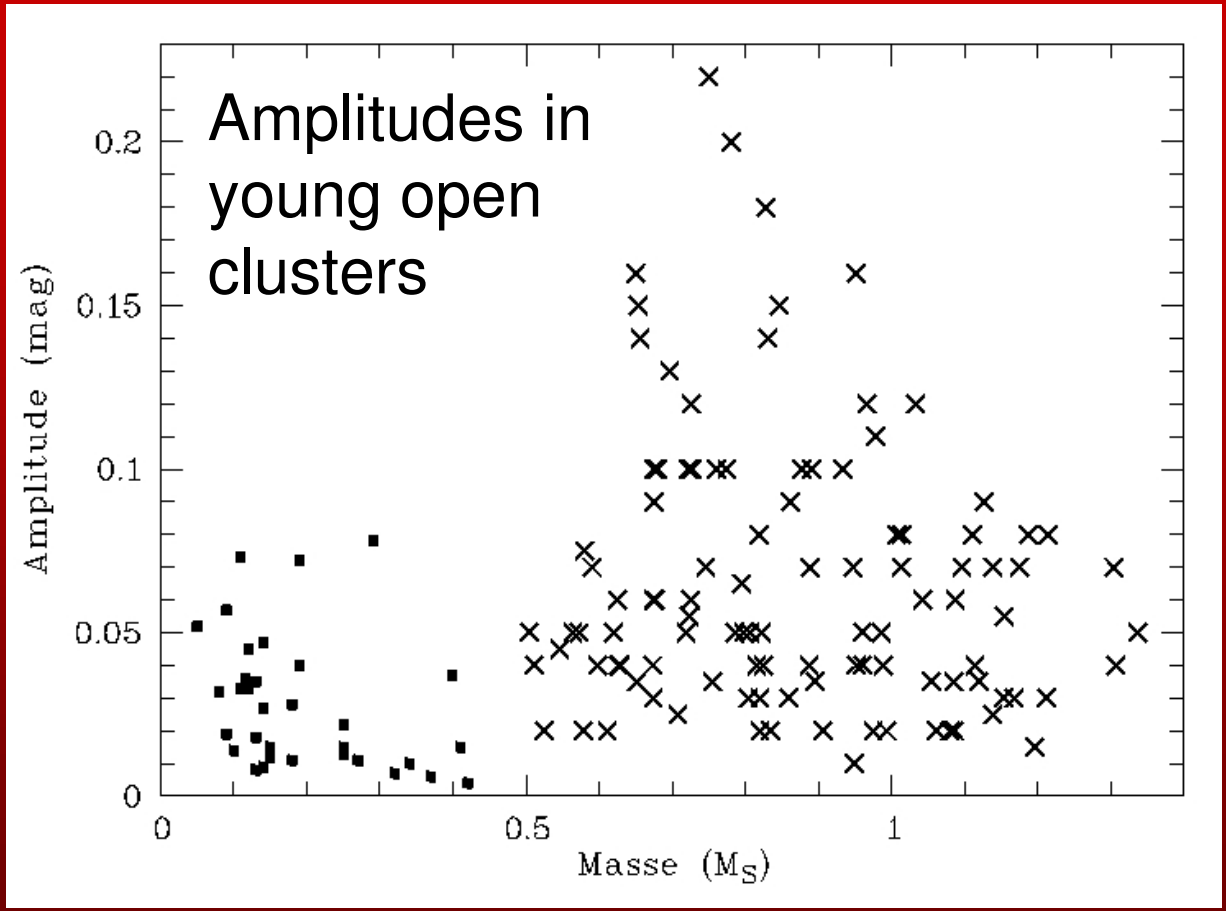
Skumanich braking is too strong

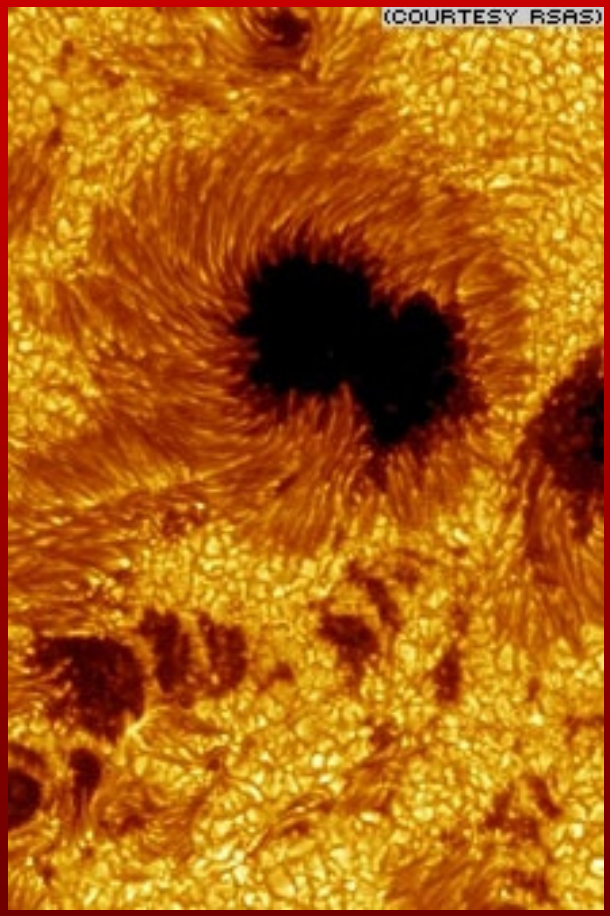
Contraction + exponential braking



best agreement of model and observations

Amplitudes vs. mass





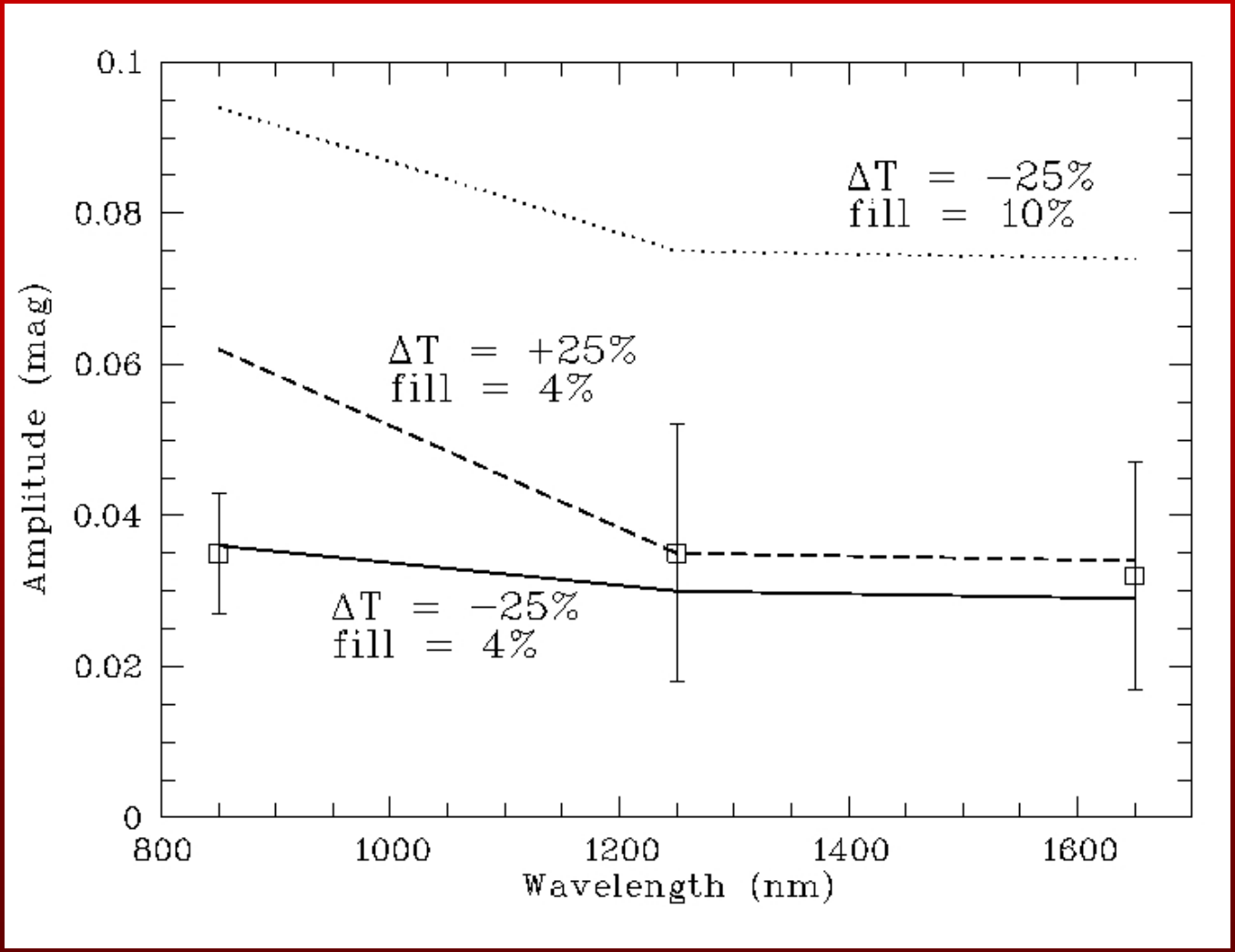
VLM objects: low amplitudes, low rate of active objects
$\Rightarrow$ change in spot properties

Multi-filter monitoring

Calar Alto Observatory, 1.2m and 2.2m telescope

simultaneous monitoring with two telescopes in I, J, H

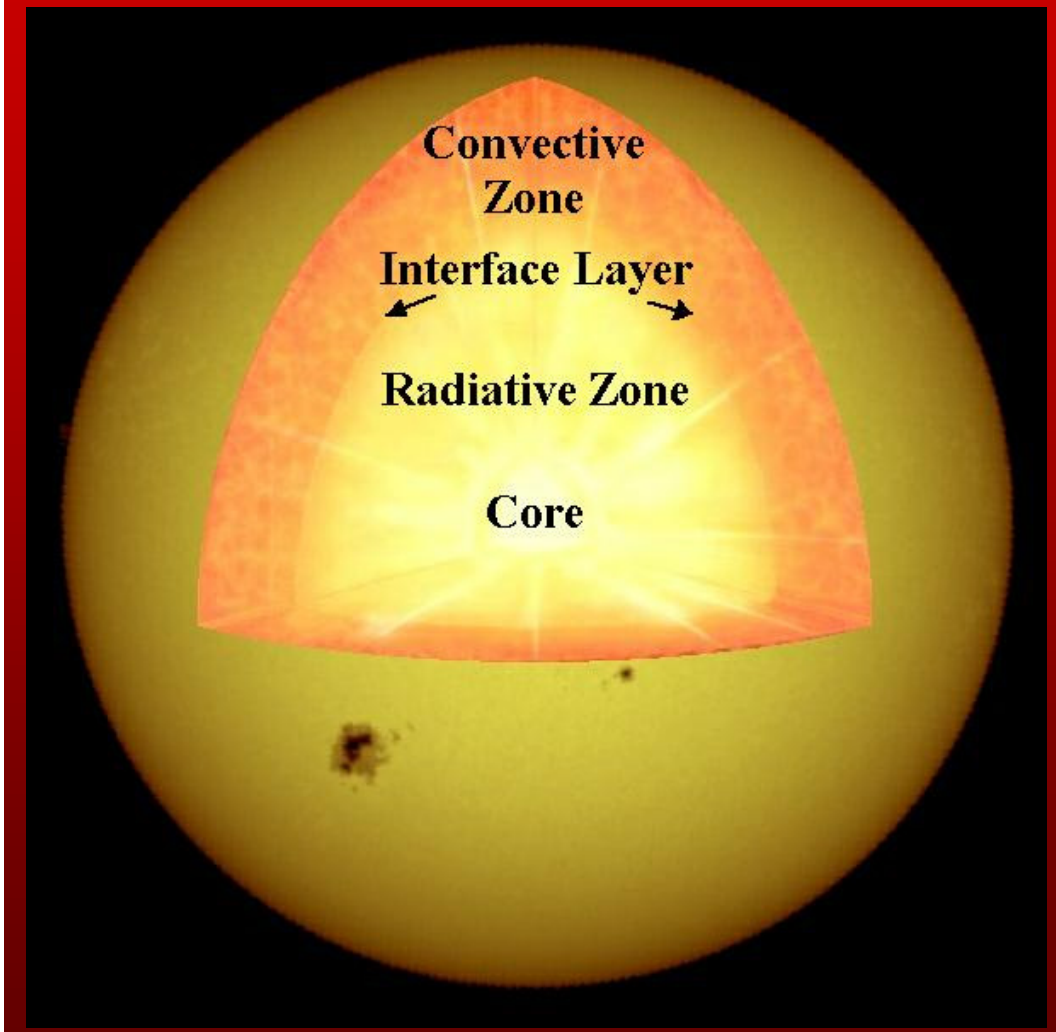
Spot properties



Scholz, Eislöffel & Froebrich, A&A, in press

cool spots, either symmetric distribution or low spot coverage

Magnetic field generation



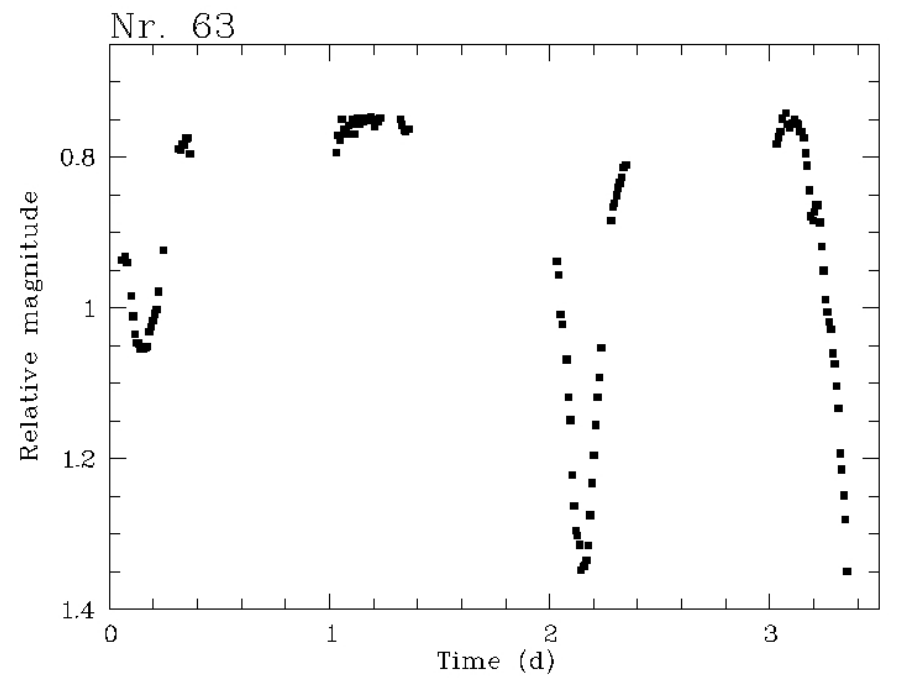
Fully convective objects:

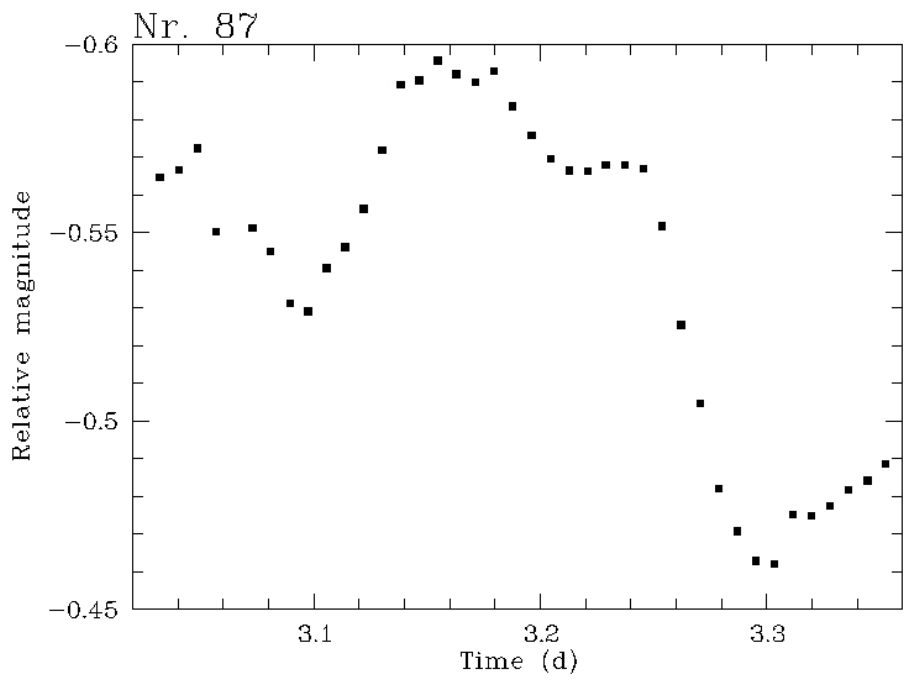
no interface layer
$\Rightarrow$ solar-type $\alpha\omega$-dynamo,
$\Rightarrow$ only small-scale magnetic fields?

inefficient wind braking
$\Rightarrow$ fast rotation

symmetric spot distribution
$\Rightarrow$ small amplitudes

High-amplitude variability



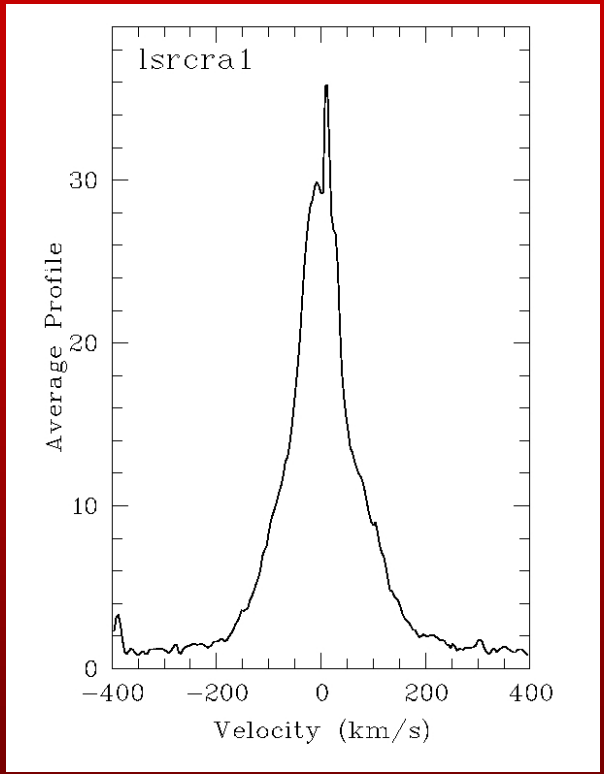


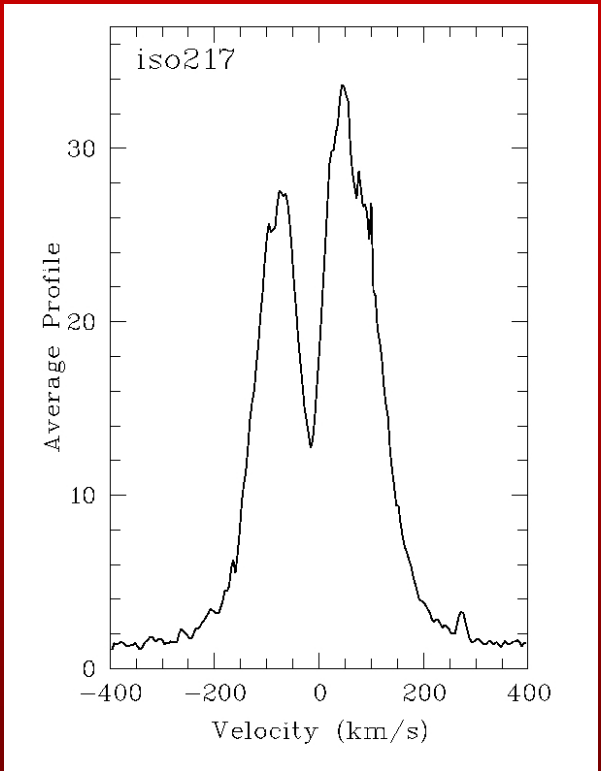
11 objects with large amplitudes, partly irregular variability

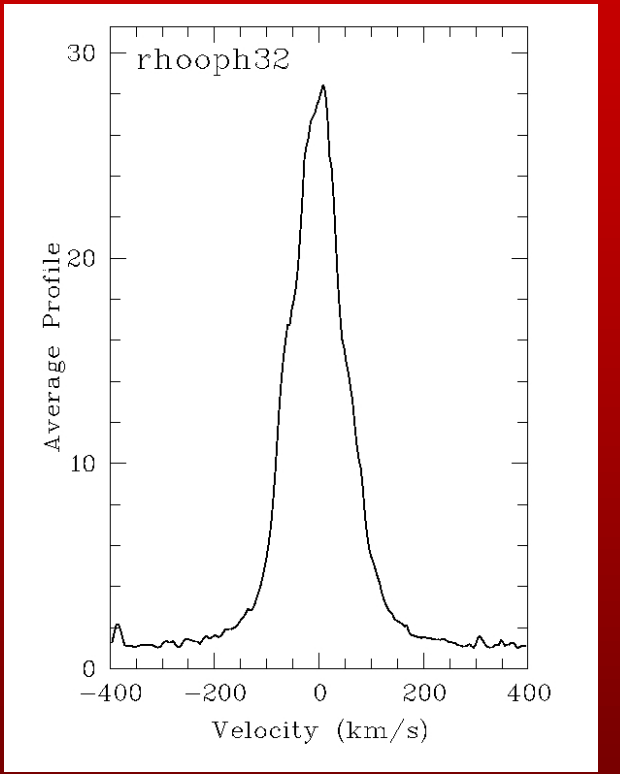
„T Tauri lightcurves“ - produced by accretion in hot spots

Scholz & Eislöffel, A&A, 2005

Spectroscopic monitoring



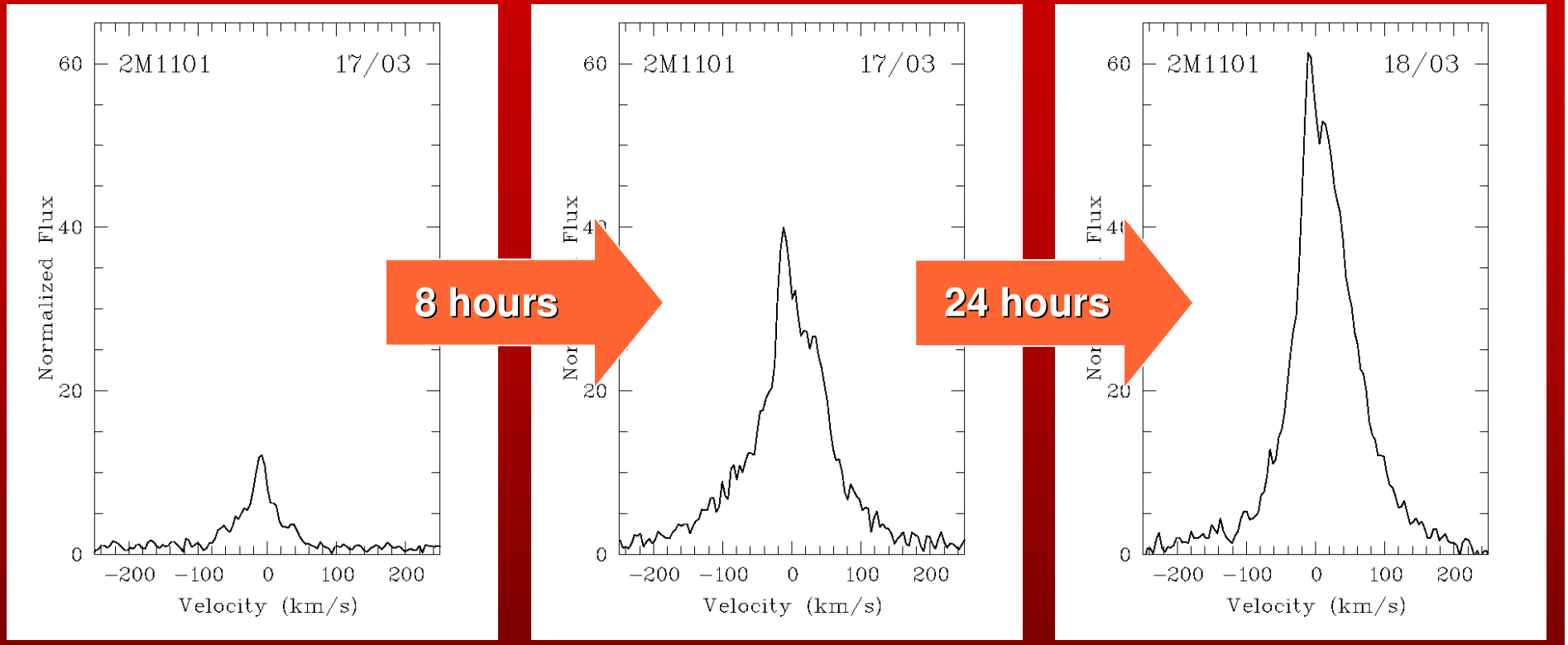




accretion = strong emission line variability

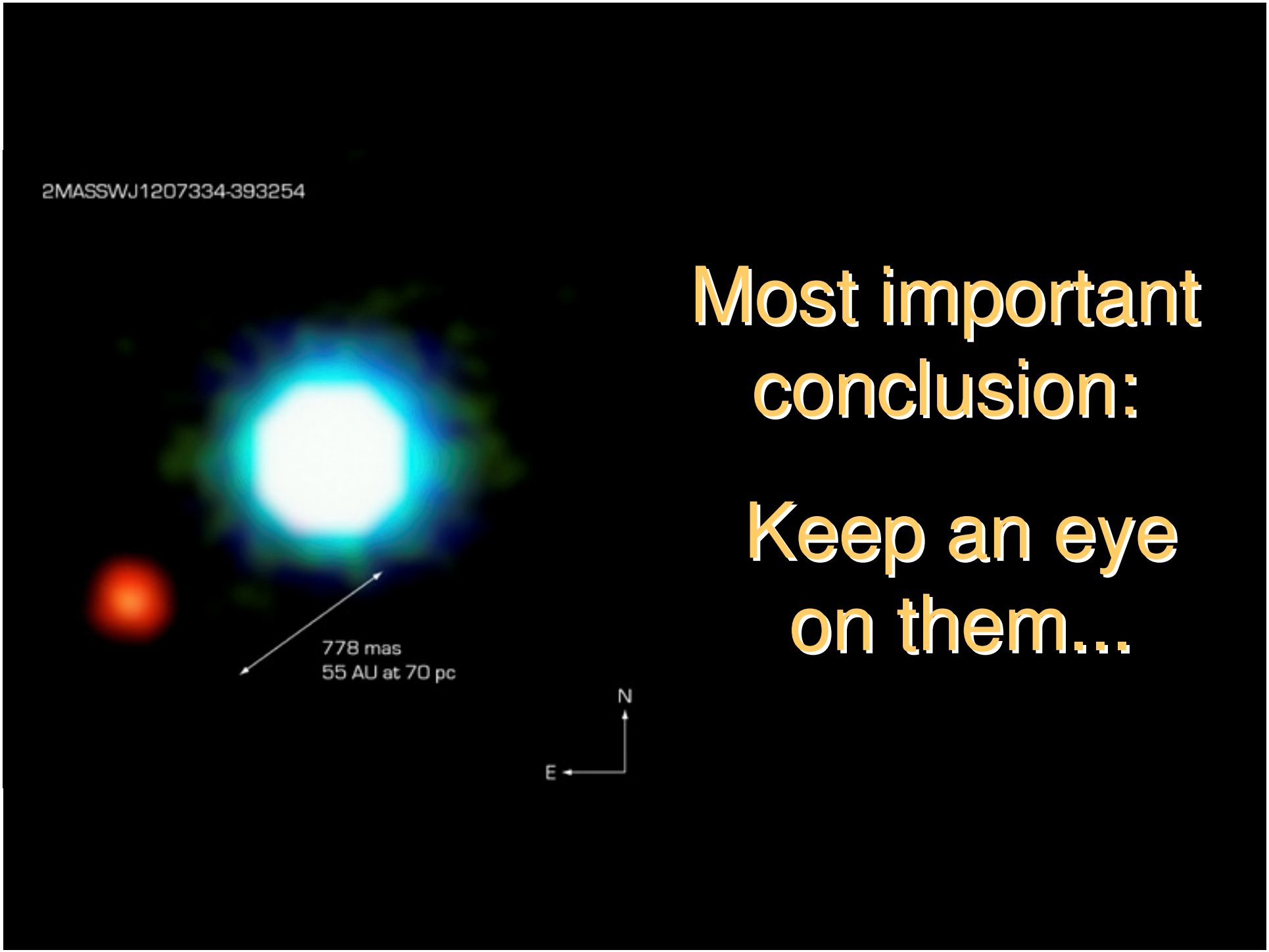
Hα line: σ(EW) = 22-90% σ(10%width) = 4-30%

2M1101-7718



10% width:	122	232	194 km/s
EW:	12	92	126 Å
other lines:		+HeI,CaII,Hβ	+HeI,CaII,Hβ,Hγ

⇒ strong variations in the accretion rate



Most important conclusion:

Keep an eye on them...

... because you never know