Sistemi stellari giovani e formazione stellare

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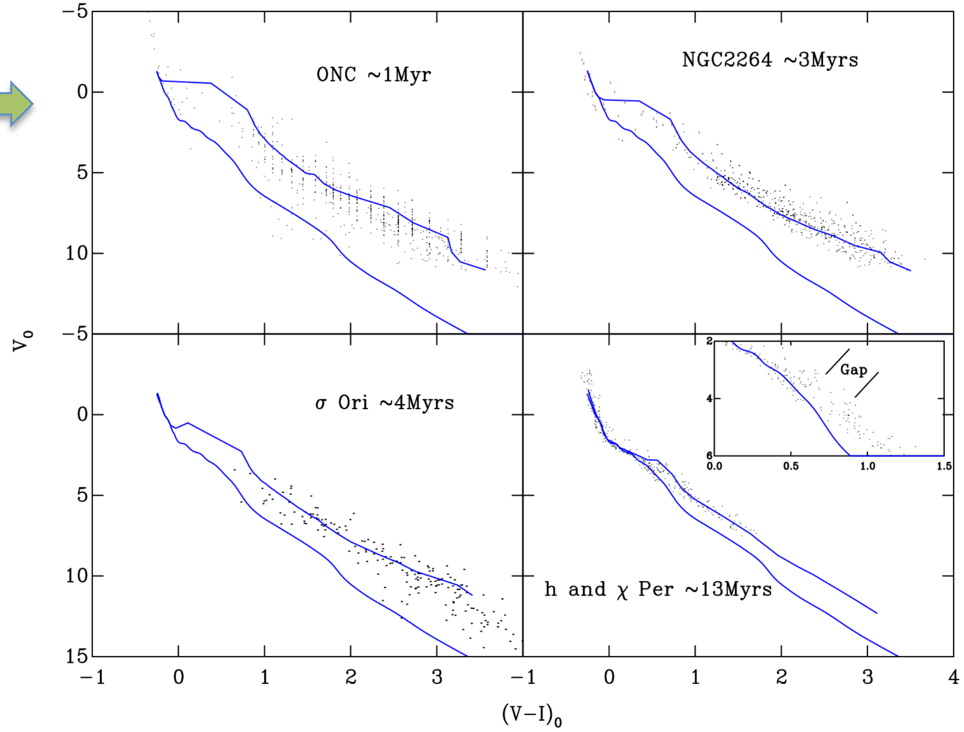
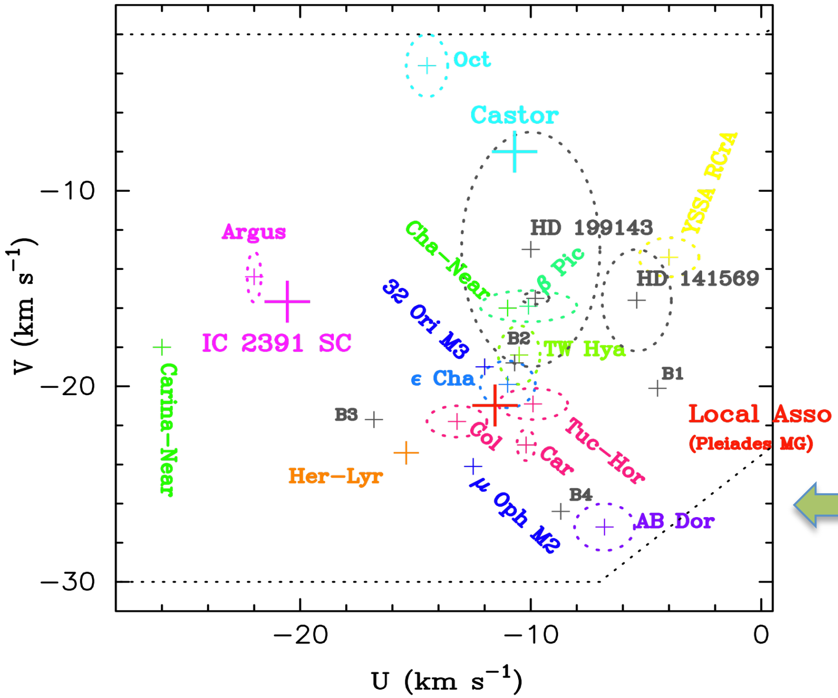
Sistemi stellari giovani

Ammassi aperti giovani (OC)



Young nearby loose association (YNLA)



Hierarchical cluster formation
(dynamic, e.g. Bonnell et al. 2008)

vs.

Quasi-equilibrium
(e.g. Tan et al. 2006)

Strong velocity gradients if are formed in sub-virial conditions
(e.g. Proszkow et al. 2009)

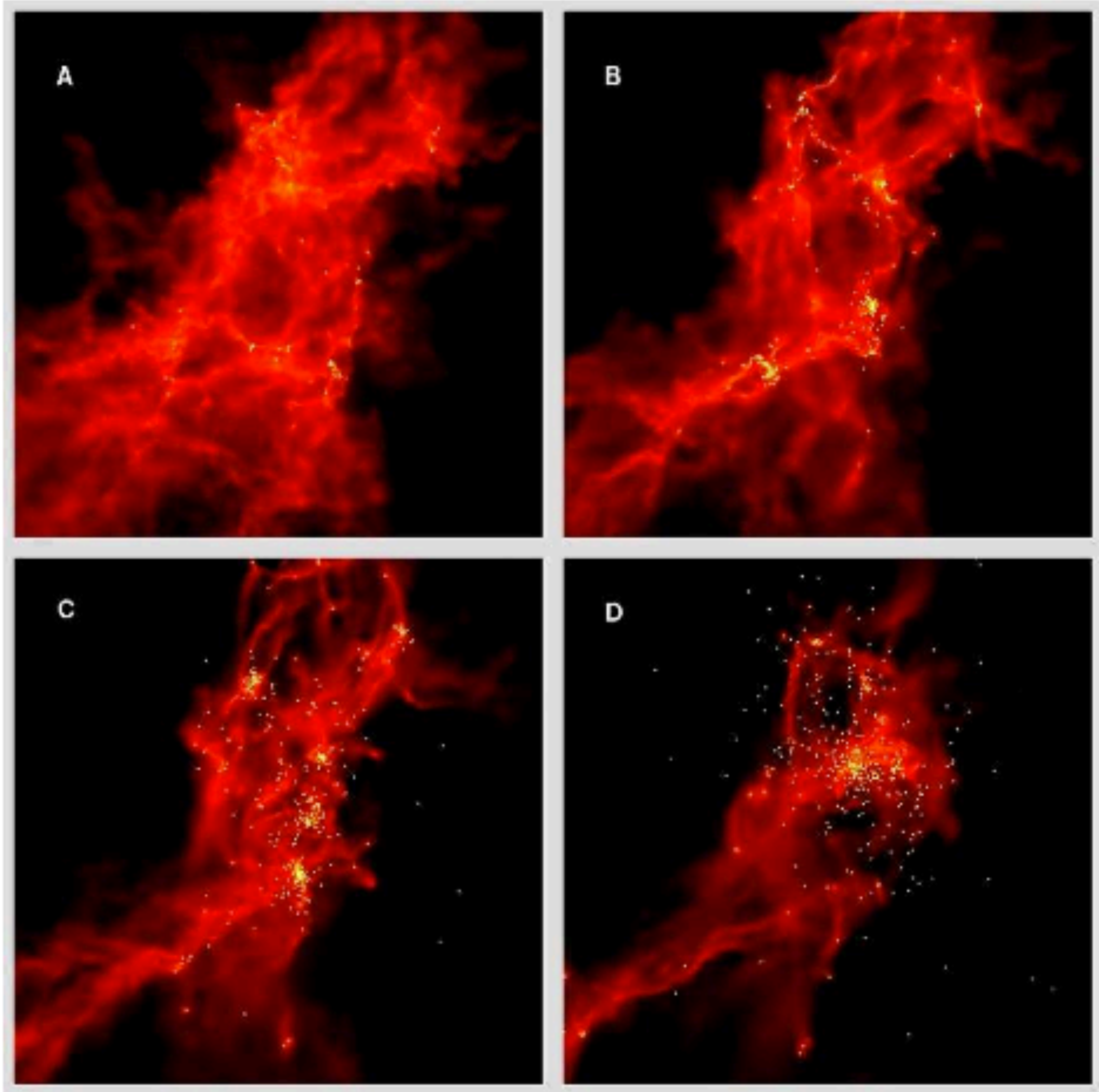
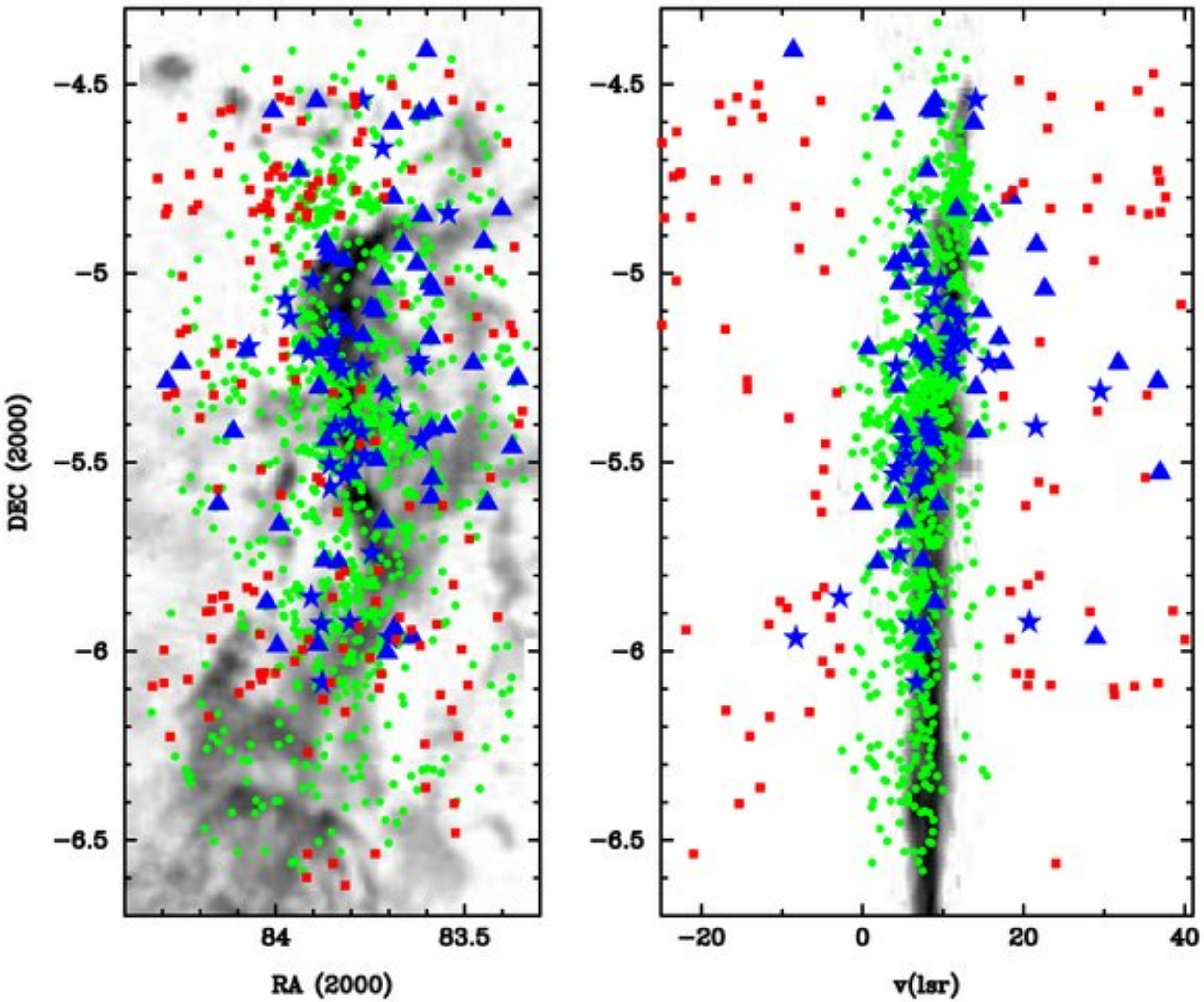


Figure 1. The stellar cluster forms through the hierarchical fragmentation of a turbulent molecular cloud. Each panel shows a region 1 parsec on a side. The logarithm of the column density is plotted from a minimum of 0.025 (black) to a maximum of 250 (white) g cm^{-3}. The stars are indicated by the white dots. The four panels capture the evolution of the 1000 $M_\odot$ system at times of 1.0, 1.4, 1.8 and 2.4 initial free-fall times, where the free-fall time for the cloud is $t_{ff} = 1.9 \times 10^5$ years. The turbulence causes shocks to form in the molecular cloud, dissipating kinetic energy and producing filamentary structure which fragment to form dense cores and individual stars (panel A). The stars fall towards local potential minima and hence form subclusters (panel B). These subclusters evolve by accreting more stars and gas, ejecting stars, and by mergers with other subclusters (panel C). The final state of the simulation is a single, centrally condensed cluster with little substructure (panel D). The cluster contains more than 400 stars and has a gas fraction of approximately 36 per cent.

Figure from John J. Tobin et al. 2009 ApJ 697 1103

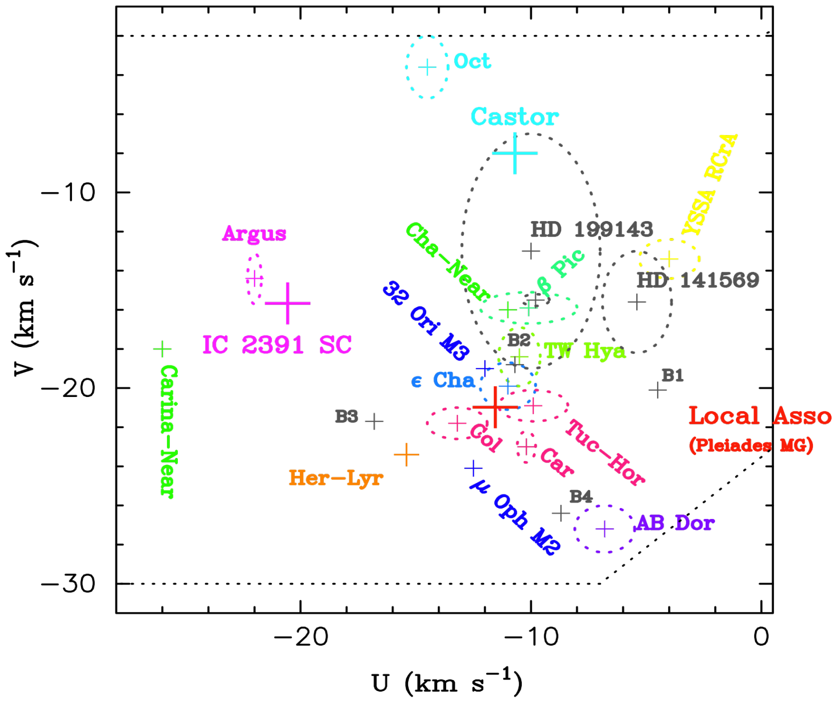


PV-plot in the ONC

Binaries: blue
IR-excess: star points
No IR-excess: triangles

In general stars with a velocity deviant from the cluster are located in regions without dense gas

YNLA



- Evaporation of open clusters ?
- Remnants of a SF region ?
- Juxtaposition of little star formation bursts ?

Impatto di Gaia: 6D

- posizione angolare
- distanza
- moti propri
- velocità radiale

→

- Evoluzione dinamica
- Evaporazione OC
- OC vs YNLA
- sotto-strutture

Impatto di Gaia: 12D+

- 6D + parametri astrofisici + variabilità

- luminosità,
- raggi,
- età,
- massa,
- rotazione,
- sistemi multipli,
- attività magnetica

- evoluzione stellare,
- formazione stellare: IMF
- segregazione di massa
- formazione pianeti

GES radial velocity

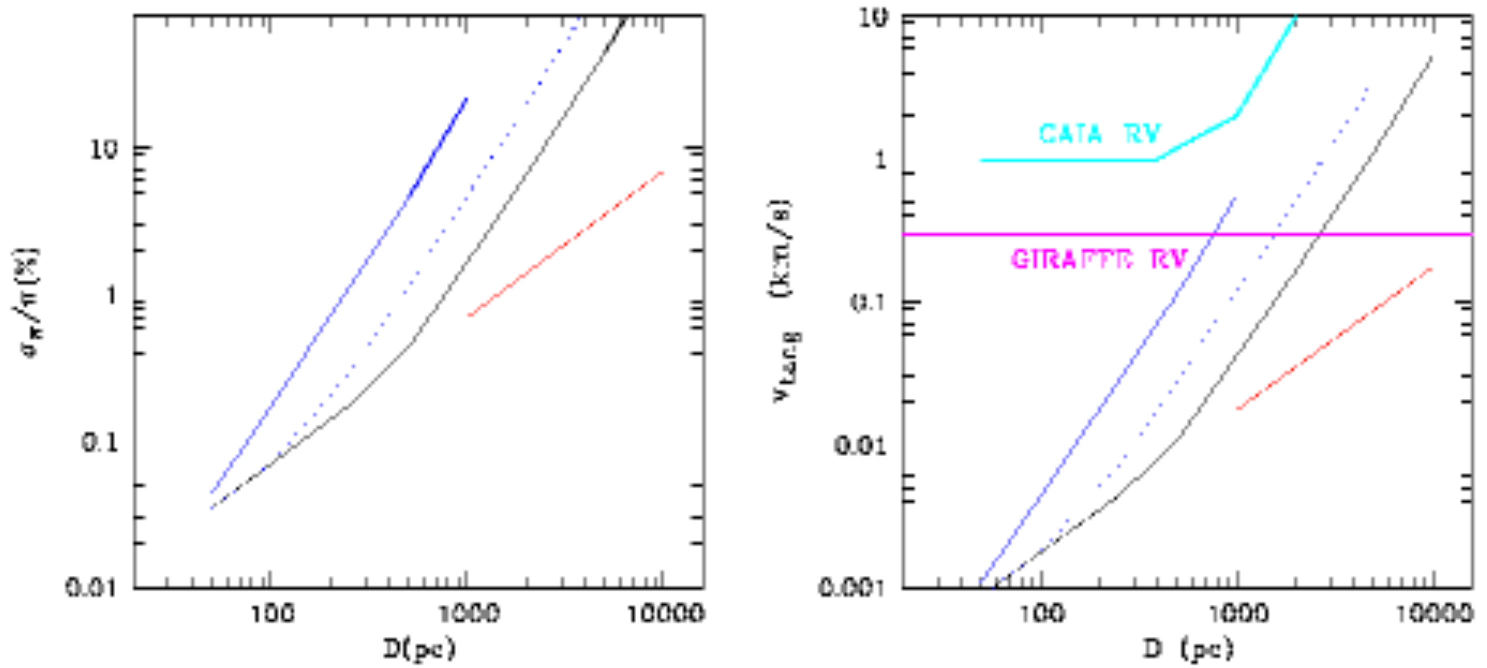


Figure 1: Gaia accuracy for parallaxes and tangential velocities (from proper motions) as a function of cluster distance. Red, black, and blue curves indicate B2V, G2V, M2V (dotted: pre-main sequence; solid: main sequence) dwarfs. The cyan line in the right-hand panel indicates the RV accuracy provided by Gaia for a G2 dwarf. The magenta line instead denotes the RV accuracy achievable for late-type stars with Giraffe.

Gaia-ESO: Young Open Clusters

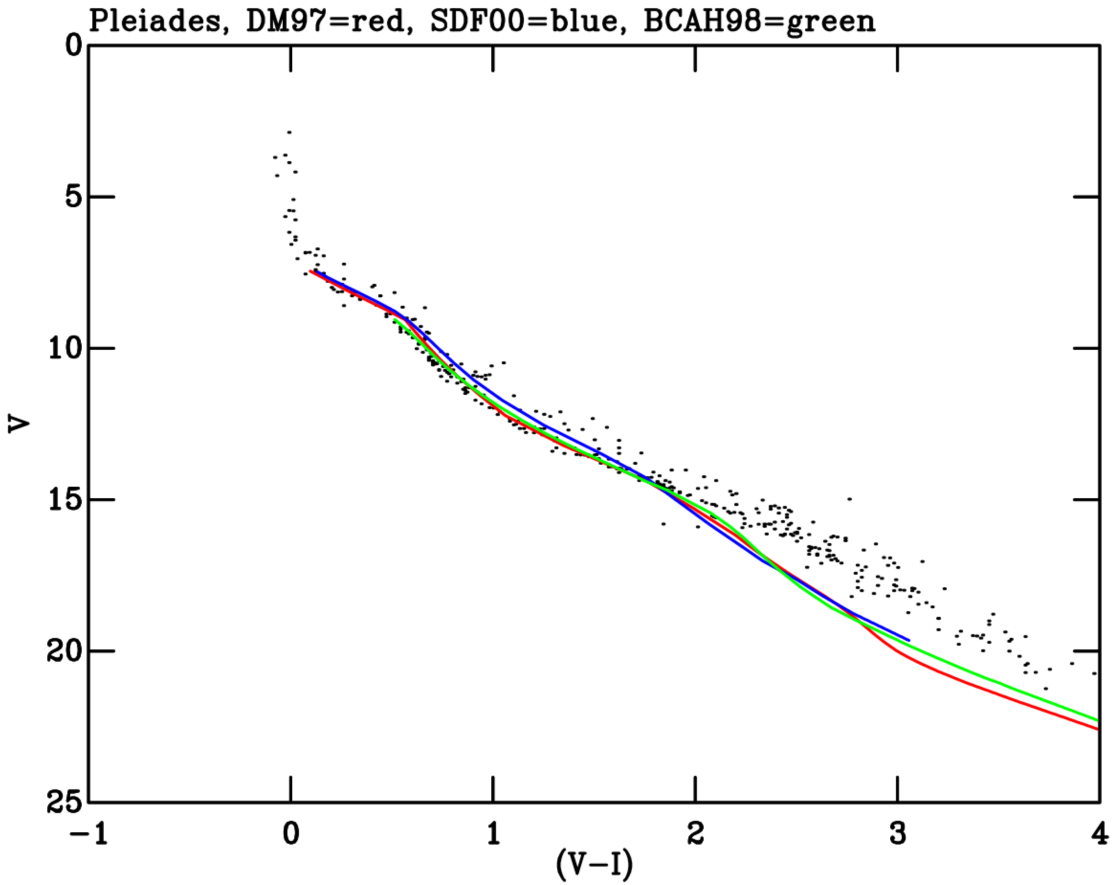
- Analisi delle stelle di PMS:
  - Parametri stellari: Teff, logg, [Fe/H]
  - Velocità radiali con accuratezza ~ 0.3 Km/s (GIRAFFE)
  - Membership accurata

    (moti propri, RV, fotometria, Teff, logg, Li, attività)
  - vsini (se combinata con Prot e raggi → i)
  - Abbondanza Li (GIRAFFE)
  - Accrescimento e perdita di massa
  - Attività cromosferica
  - UVES: [Fe/H] + abbondanze elementi

Gaia + Gaia-ESO

- Vincoli sui modelli di formazione e dissipazione degli ammassi.
- Sotto-strutture
- IMF
- Relazione tra OC e YNLA
- Effetti ambientali sull'accrescimento e sui dischi protoplanetari in PMS
- 'Chemical tagging': scenari per la SF
- Età dall'abbondanza del Li
- Evoluzione del momento angolare e dell'attività magnetica (età)
- Stelle variabili
- Binarie e binarie ad eclisse (vincoli sui modelli)
- Processi di mescolamento interno (da abbondanza elementi leggeri)

Analisi accurata CMD



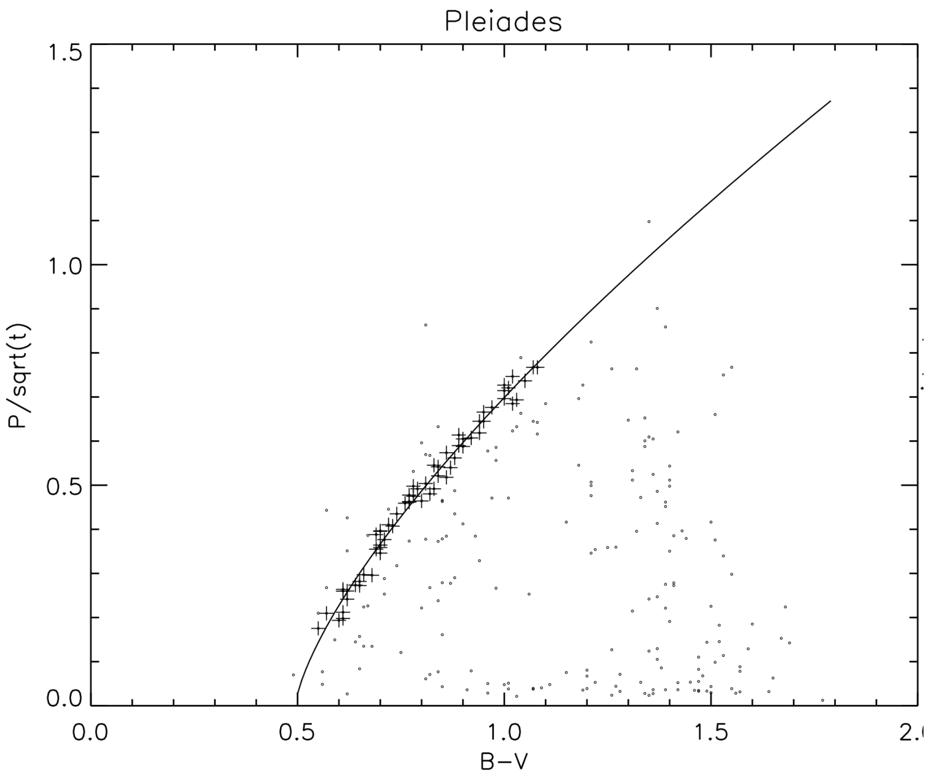
Isocrone PMS

Eventi di formazione multipli o estesi nel tempo?

Correlazioni con le proprietà generali del cluster?

Gaia: identificazione delle stelle non più legate al cluster o al limite

Oltre l'età nucleare



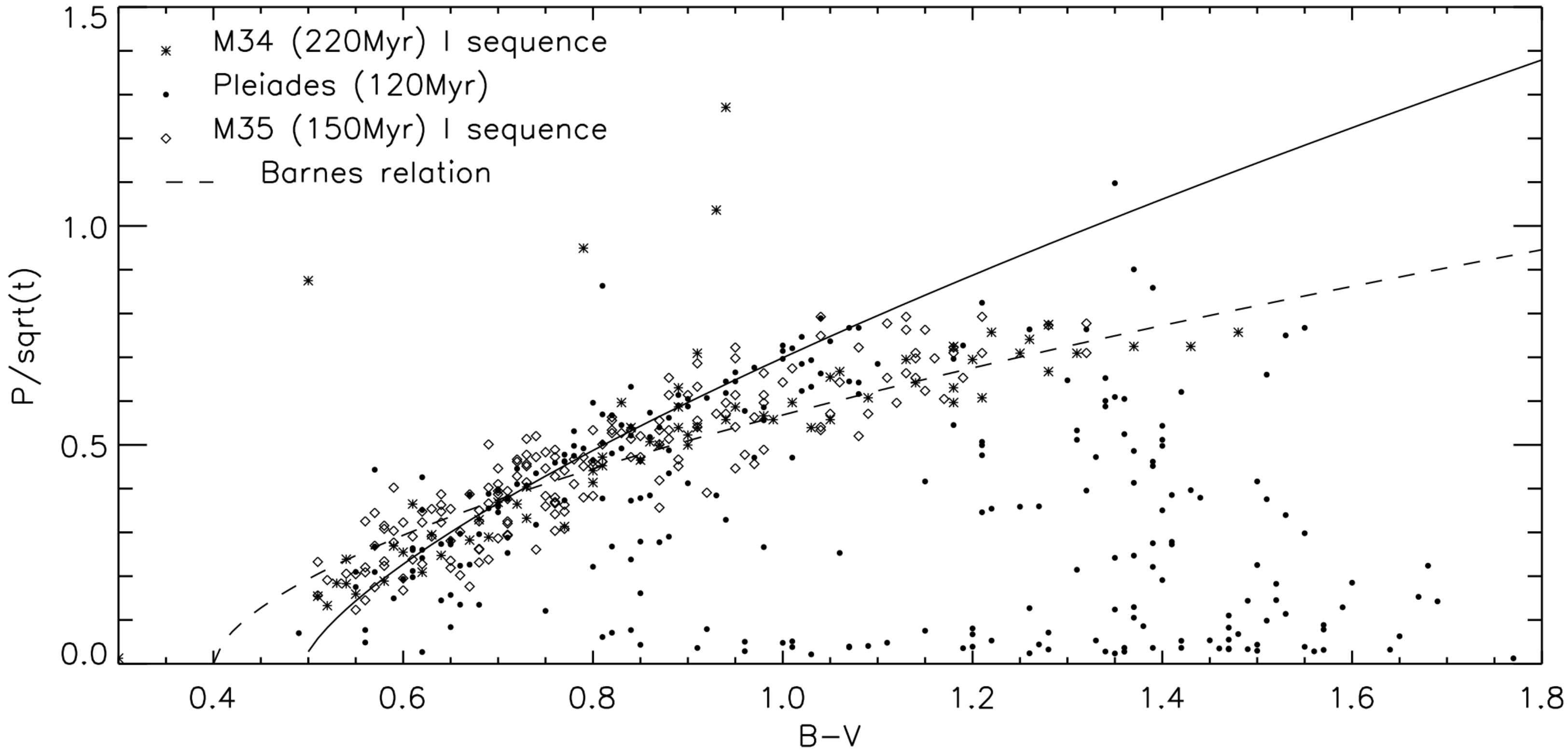
Rotazione (e attività) come misura dell'età.

Influenza dell'ambiente (sistema) sulla storia rotazionale e attività

Relazione con dischi protoplanetari
(in quali condizioni si possono formare pianeti?)

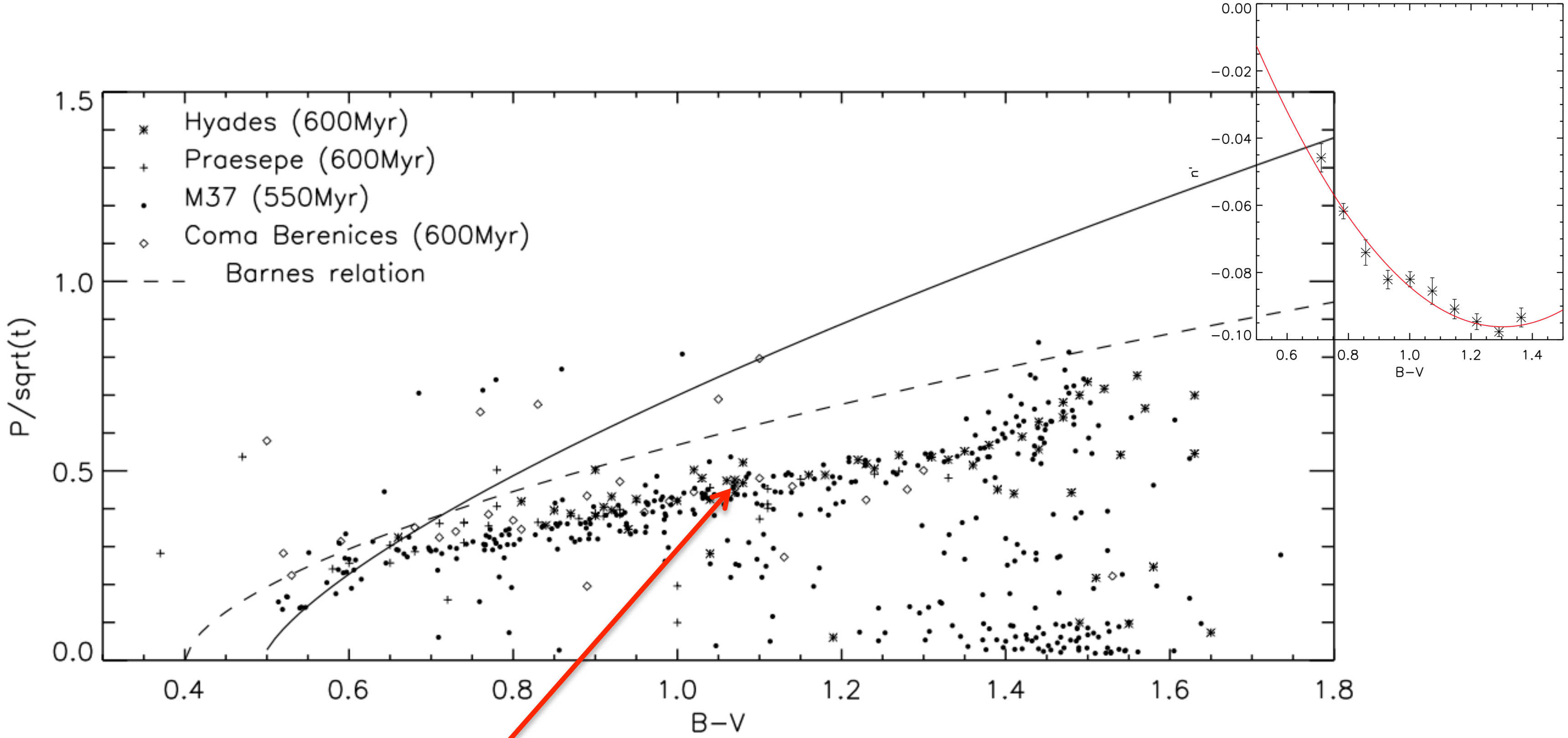
Lanzafame et al. in preparation
data from Hartman et al (2010)

Rotational periods in the Pleiades, M35, and M34



Lanzafame et al. in preparation
data from:
Hartman et al (2010)
Meibom et al. (2009, 2011)

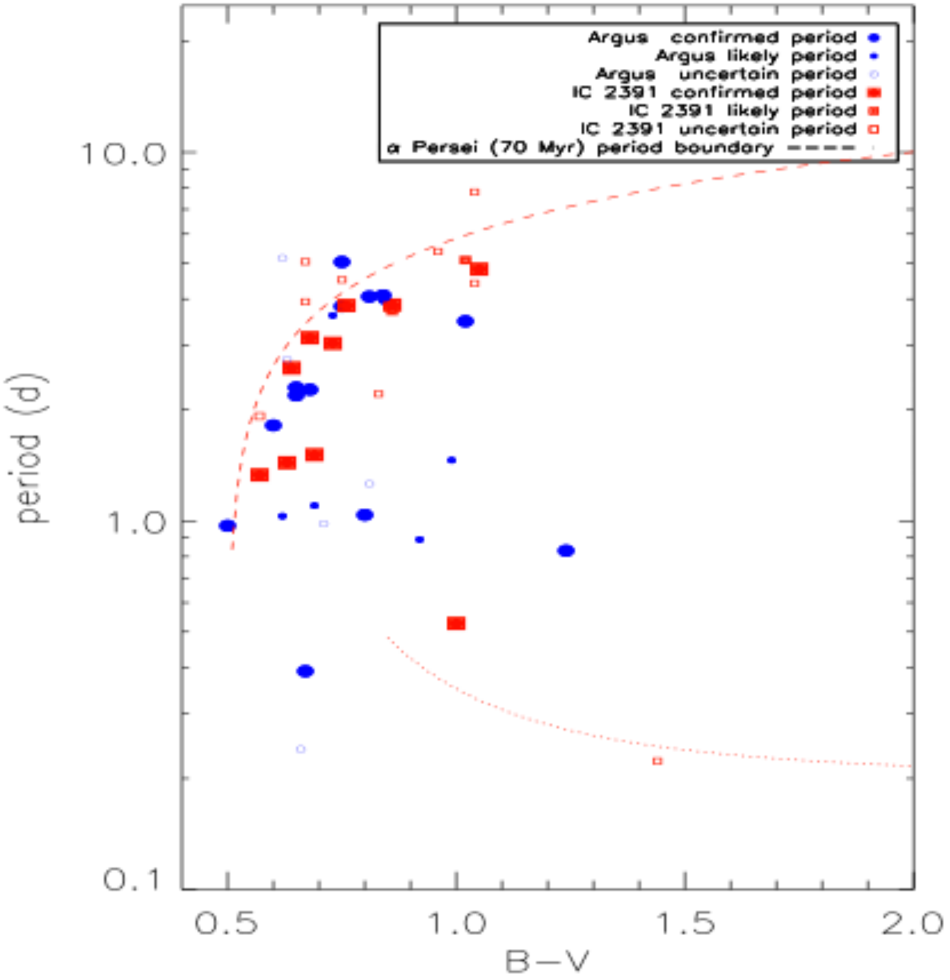
Rotational periods in M37, Hyades, Praesepe and Coma Berenices



Breakdown of Skumanich law

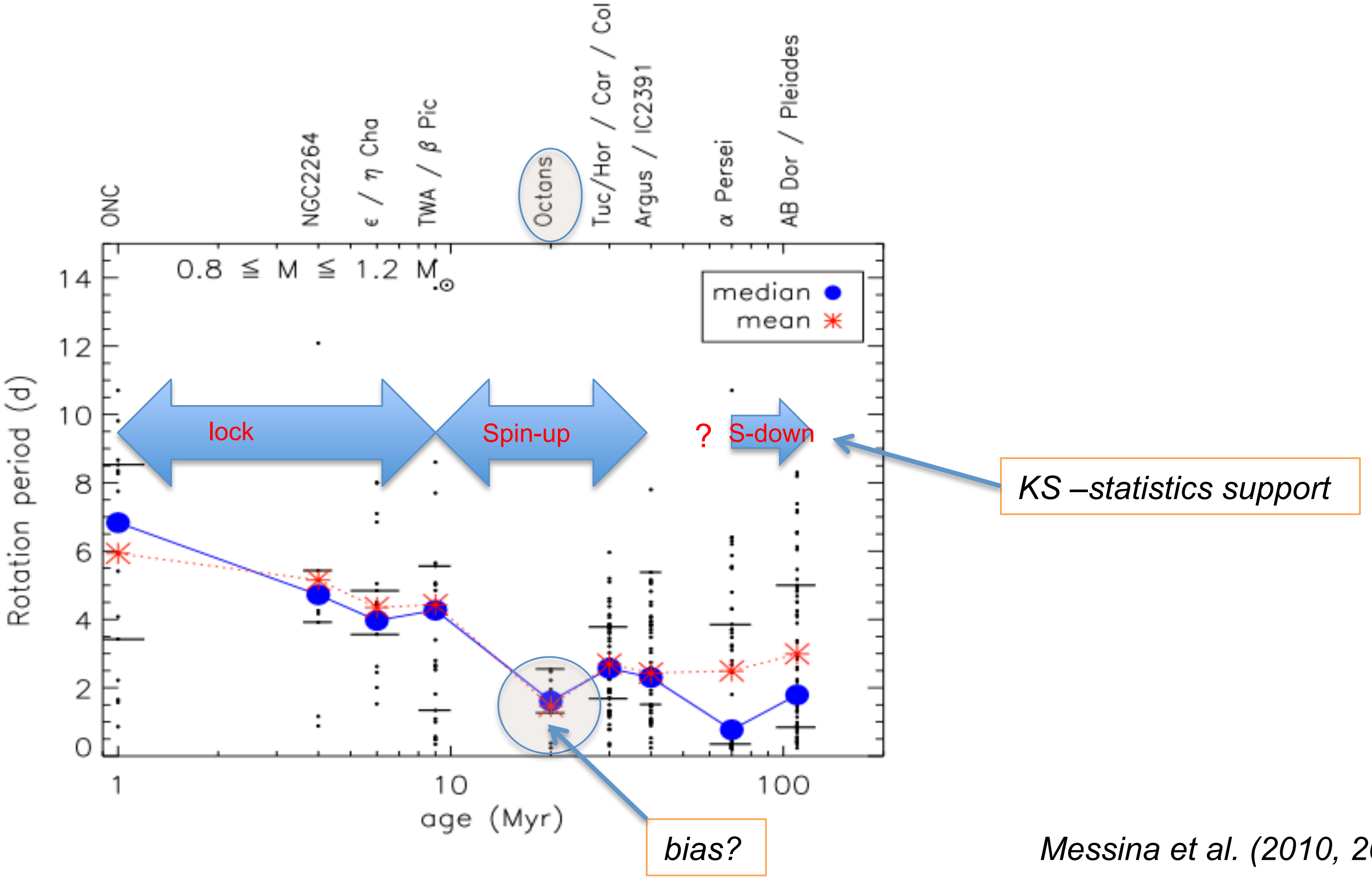
Lanzafame et al. in preparation
data from:
Hartman et al (2010)
Meibom et al. (2009, 2011)

Relazione con associazioni giovani sparse.



Messina et al. (2010, 2011)

Filling gaps in age with young loose associations



Messina et al. (2010, 2011)

PMS disk lifetime

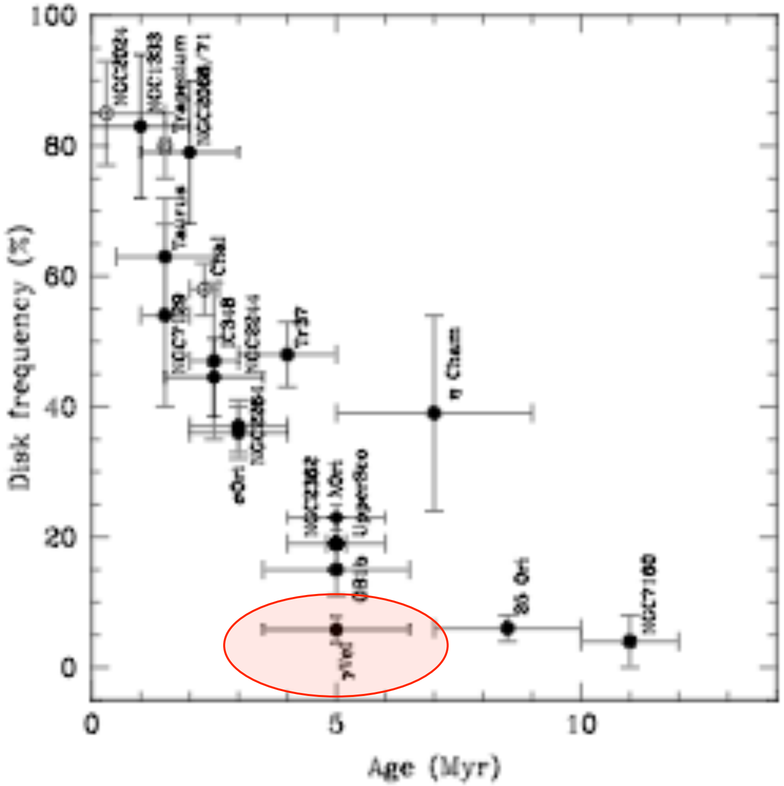


FIG. 11.—Fraction of stars with near-infrared disk emission as a function of the age of the stellar group. Open circles represent the disk frequency for stars in the T Tauri (TTS) mass range (~K5 or later), derived using *JHKL* observations: NGC 2024 and Trapezium (Haisch et al. 2001), and Chameleon I (Gómez & Kenyon 2001). Solid symbols represent the disk frequency calculated for stars in the TTS mass range using *Spitzer* data (see text for references).

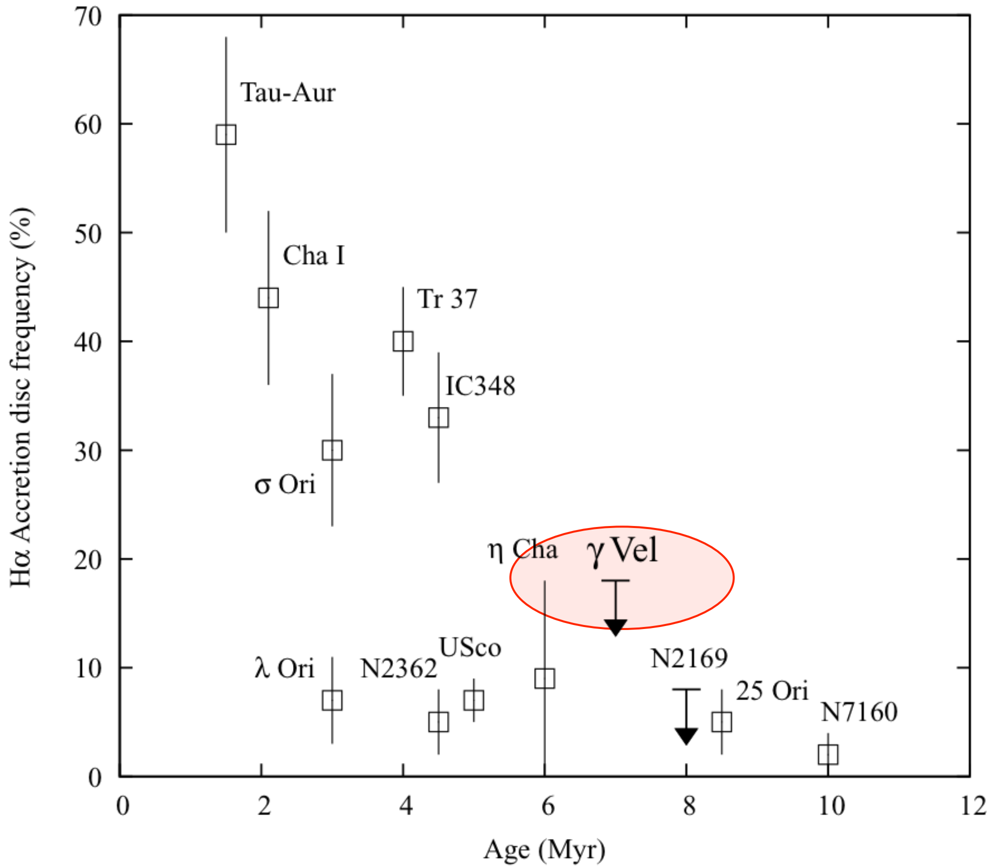
e.g. Hernandez et al. (2008)

Effects due to OB stars and/or age uncertainties ?

Related to planet formation ?

Dependence on star density ?

PMS disk lifetime

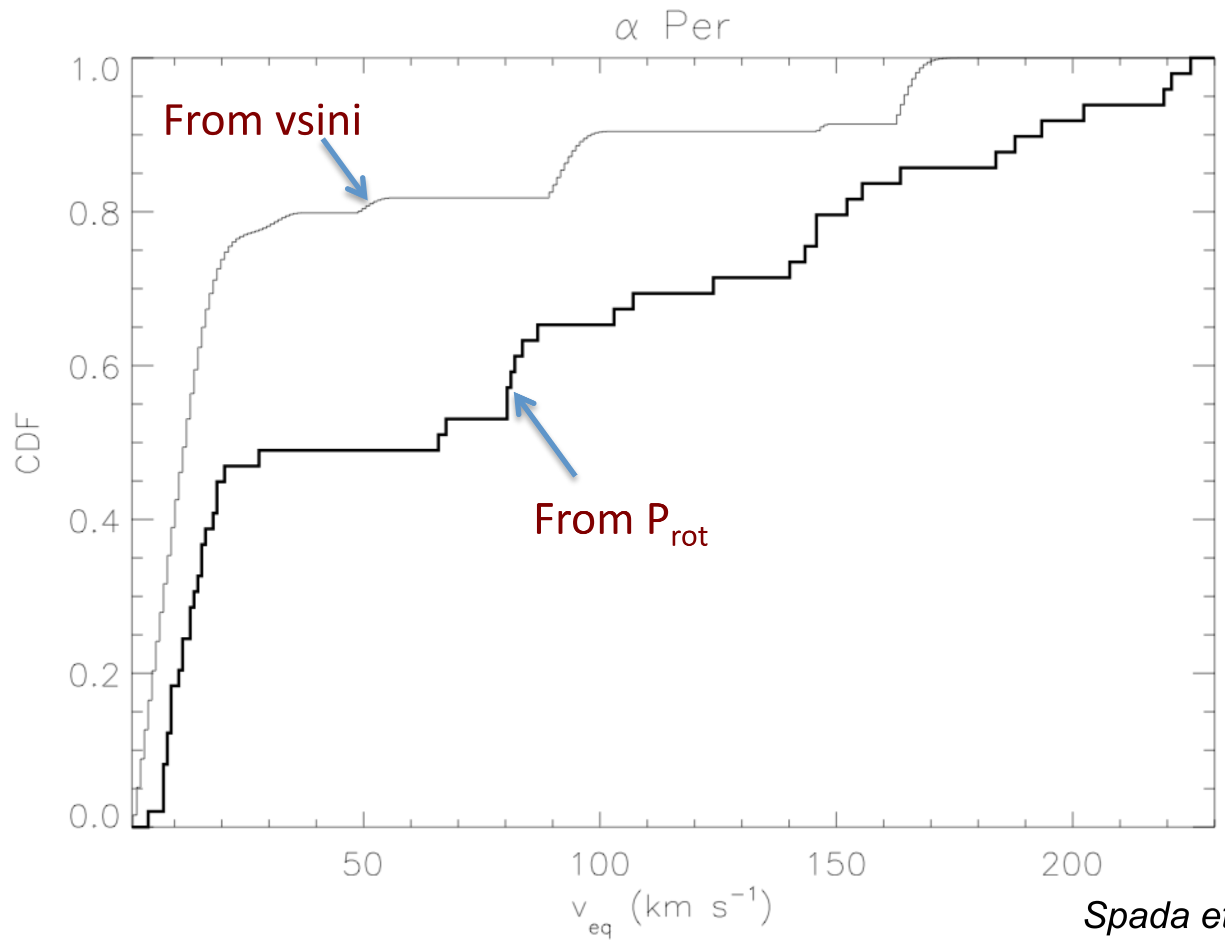


Jeffries et al. (2009)

No environmental effect?

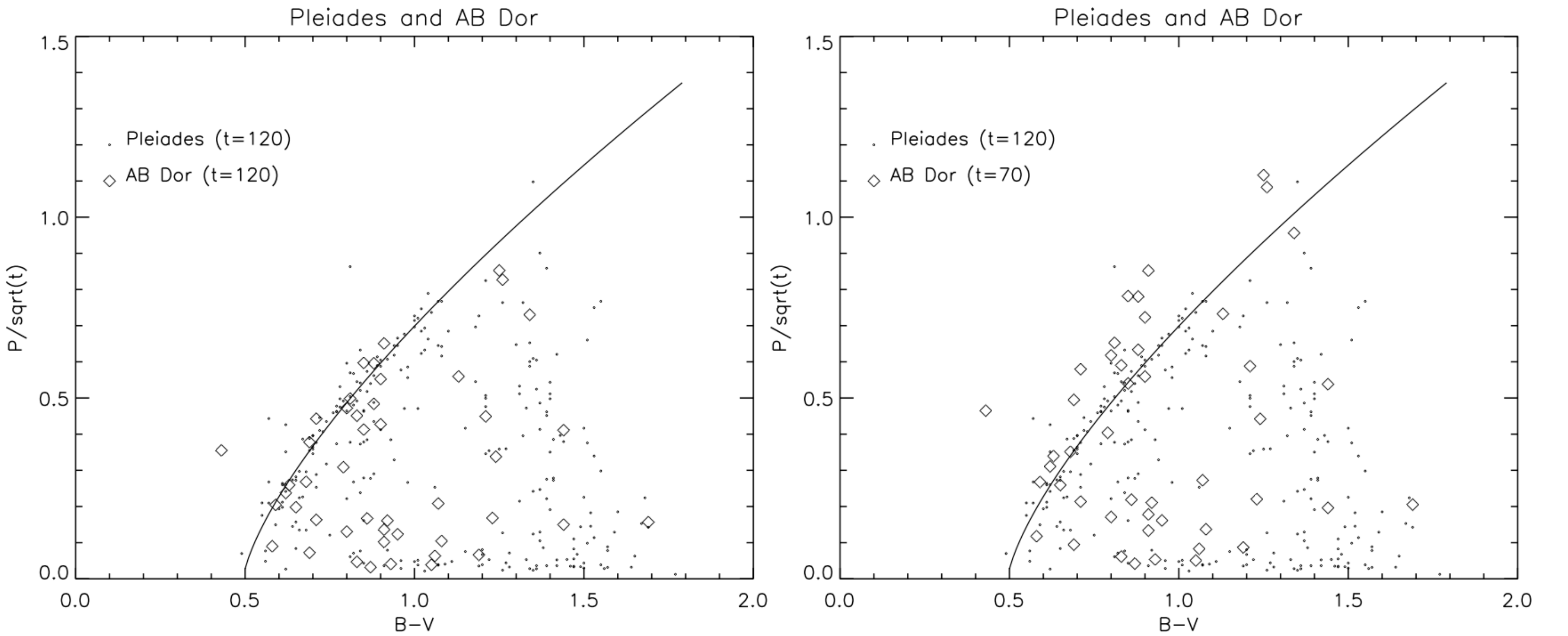
Spread in stellar age?

Alpha Persei v_{eq} distribution



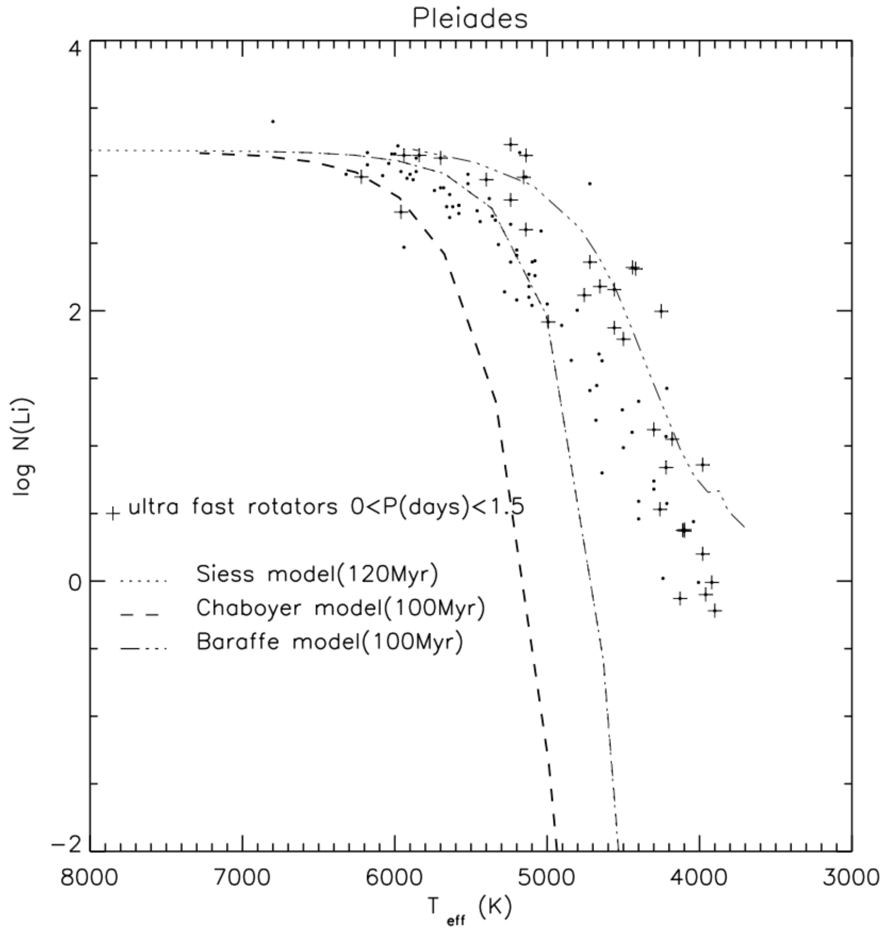
Spada et al. (2011)

Rotation age of AB Dor



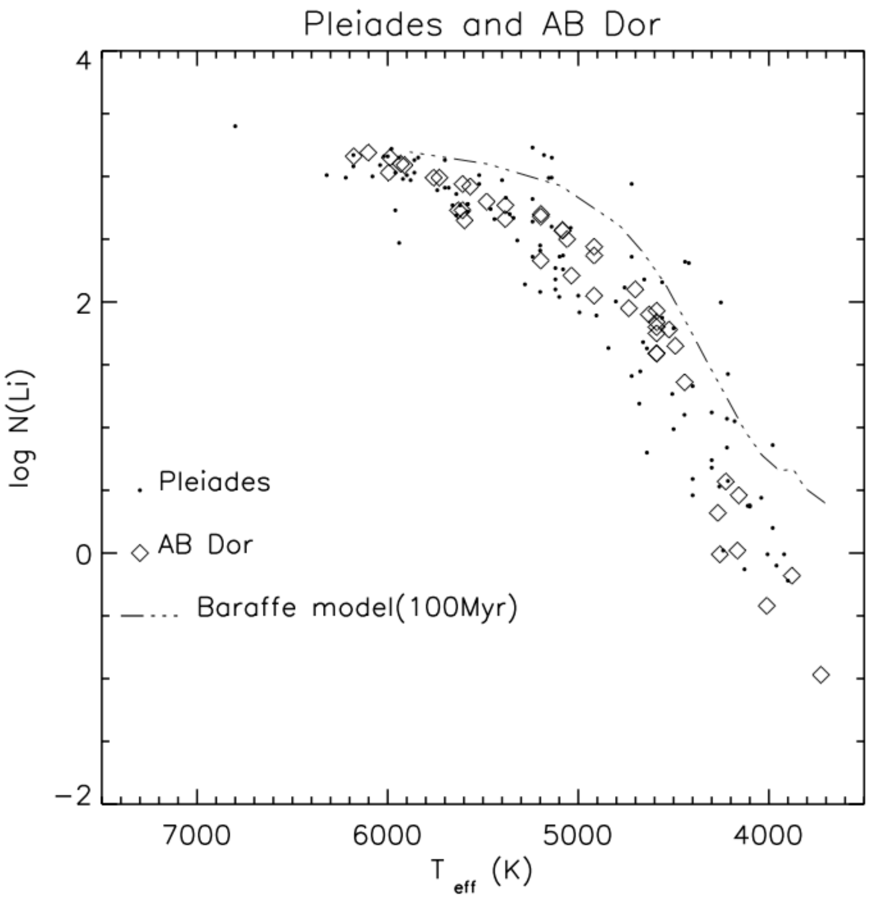
Lanzafame et al. in preparation

Li abundance vs. rotation



Lanzafame et al. in preparation

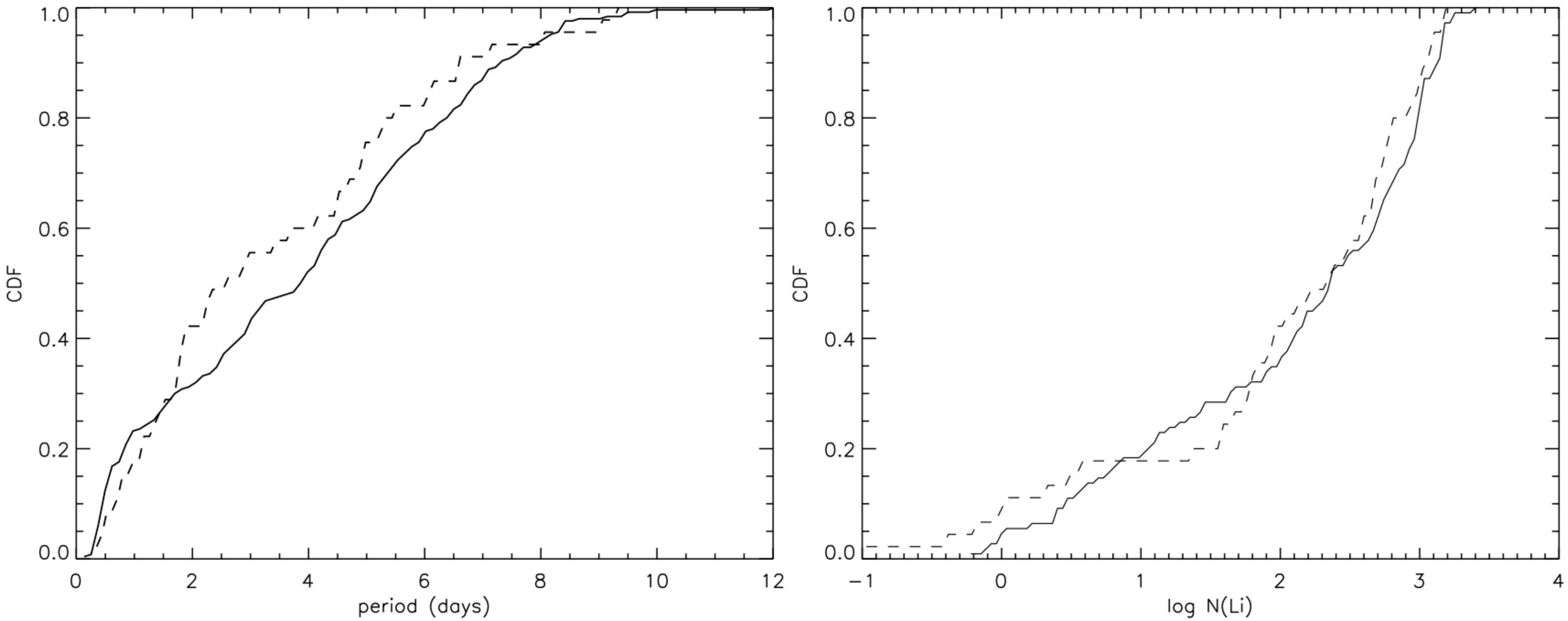
Li abundance vs. rotation: ambient?



AB Dor association vs. Pleiades
Same age?

Lanzafame et al. in preparation

Li abundance vs. rotation



AB Dor vs. Pleiades: indistinguishable?

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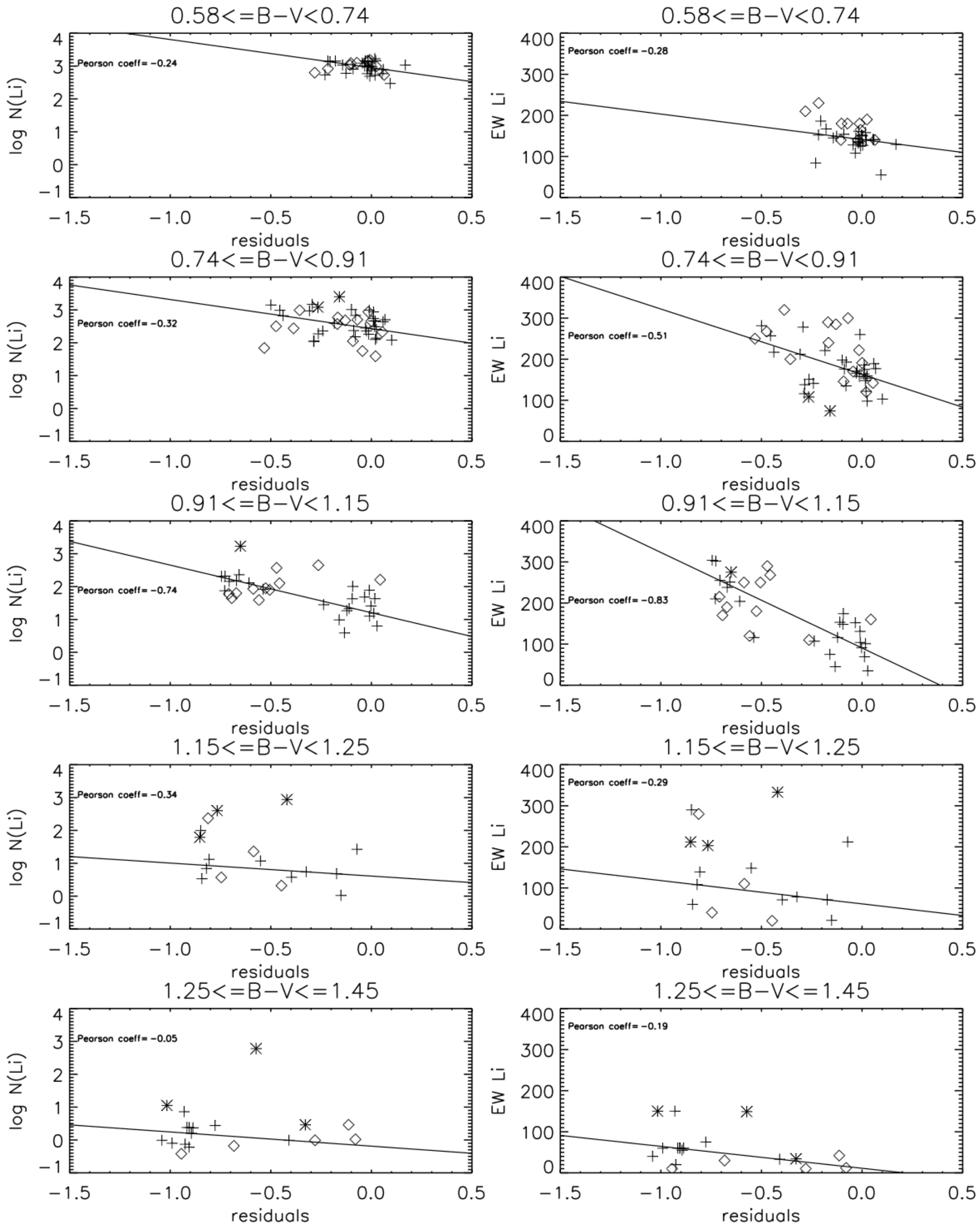

Li vs. rotation AB Dor and Pleiades

P vs. (B-V) for the
I-sequence removed

Lanzafame et al. in preparation