Exoplanet Observations with the E-ELT 2014

A Search for Giant Exoplanets around Intermediate-Mass Giant Stars in Open Clusters

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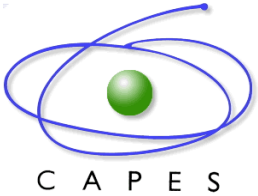


Main Goal

- Accurate measurements of **Radial Velocities** with HARPS
- 172 evolved stars with intermediate mass ($M > 1.5\ M_{\odot}$) in 24 open clusters
- Open cluster choice:
  - Well studied for **duplicity**, good constraints for **mass**, **composition** and **age** determinations.

The role of the stellar environments in the formation of planetary systems.

Search for Exoplanets

- **Field stars:**
  - ✓ Vast majority of the exoplanets discovery so far (~1050 to date).
  - ✓ Variety of stellar mass, age, chemical composition and evolutionary status.
  - ✓ 90% of hosting stars are MS star with $M < 1.3\ M_{\odot}$

Planet formation as a function of the mass of the host star, and of the stellar environments is poorly understood!

- **Metallicity:** Metal rich MS stars

Increased metallicity enhanced planet formation or, is the observed high metallicity caused by the presence of planetary systems?

(Santos et al. 2005; Gonzales et al. 2001; Murray et al. 2001)

Missing dependency between metallicity and evolved stars

Search for Exoplanets

Missing dependency between metallicity and evolved stars

- **Pasquini et al. 2007:**
  - ✓ Pollution
    - ✓ More effective on the MS
    - ✓ Evolved stages → CZ enlarge and mix a large fraction of the gas
- **Basic questions on planet formation:**
  - ✓ What is the dependency of giant planet formation on stellar metallicity, stellar mass, and… the stellar environment?
  - ✓ How specific is our solar system, and the Sun?

Planet Search in Open Clusters (OC)

Search for Exoplanets

Planet Search in Open Clusters (OC)

- **Why OCs?**
  - ✓ Stellar characteristics strictly controlled (homogeneous set of stars)
    - ✓ Same **age**, **metallicity**, and **galactocentric distance**
    - ✓ Ideal objects in the search for planets (Gonzales et al. 1997)
- **Concernings:**
  - ✓ **Metallicity** → Metal-rich OC may be excellent environments to search exoplanets?
  - ✓ **Mass** → Better determined in a OC member (establish the direct dependence)

Search for Exoplanets

Planet Search in Open Clusters (OC)

- **Planets found in OCs, general examples:**
  - ✓ 5 OCs:
    - ✓ Hyades: ε Tau - Giant star (Sato et al. 2007)
    - ✓ NGC 2423: NGC 2423-3 - Giant star (Lovis & Mayor 2007)
    - ✓ Praesepe: Pr0201 and Pr0211 – MS stars (Quinn et al. 2012)
    - ✓ NGC 6811: 2 mini-Neptunes (Meibom et al. 2013)
    - ✓ M67: YBP1194 and YBP1514 – G dwarf stars, and S364 – Giant star (Brucalassi et al. 2014)

General frequency of planets in OC is compatible with that observed in field stars.

Stellar Sample

- **OCs Sample:**
  - ✓ WEBDA (Mermilliod 1995) and Mermillod & Mayor (2008):
    - ✓ OCs with giant stars.
    - ✓ Age: Between 0.02 and a few Gyr
    - ✓ TO masses > 1.5 M
    - ✓ Brighter than V = 13.5
- **Observations Programs at ESO:**
  - ✓ ID 091.C-0438 (P91) and ID 092.C-0282 (P92)
    - ✓ 19 OCs → 100 – P91; 51 - P92 (March/2014 observations)
    - ✓ 1 to 5 observations/star (262 - P91 / 140 - P92 observations)

Results

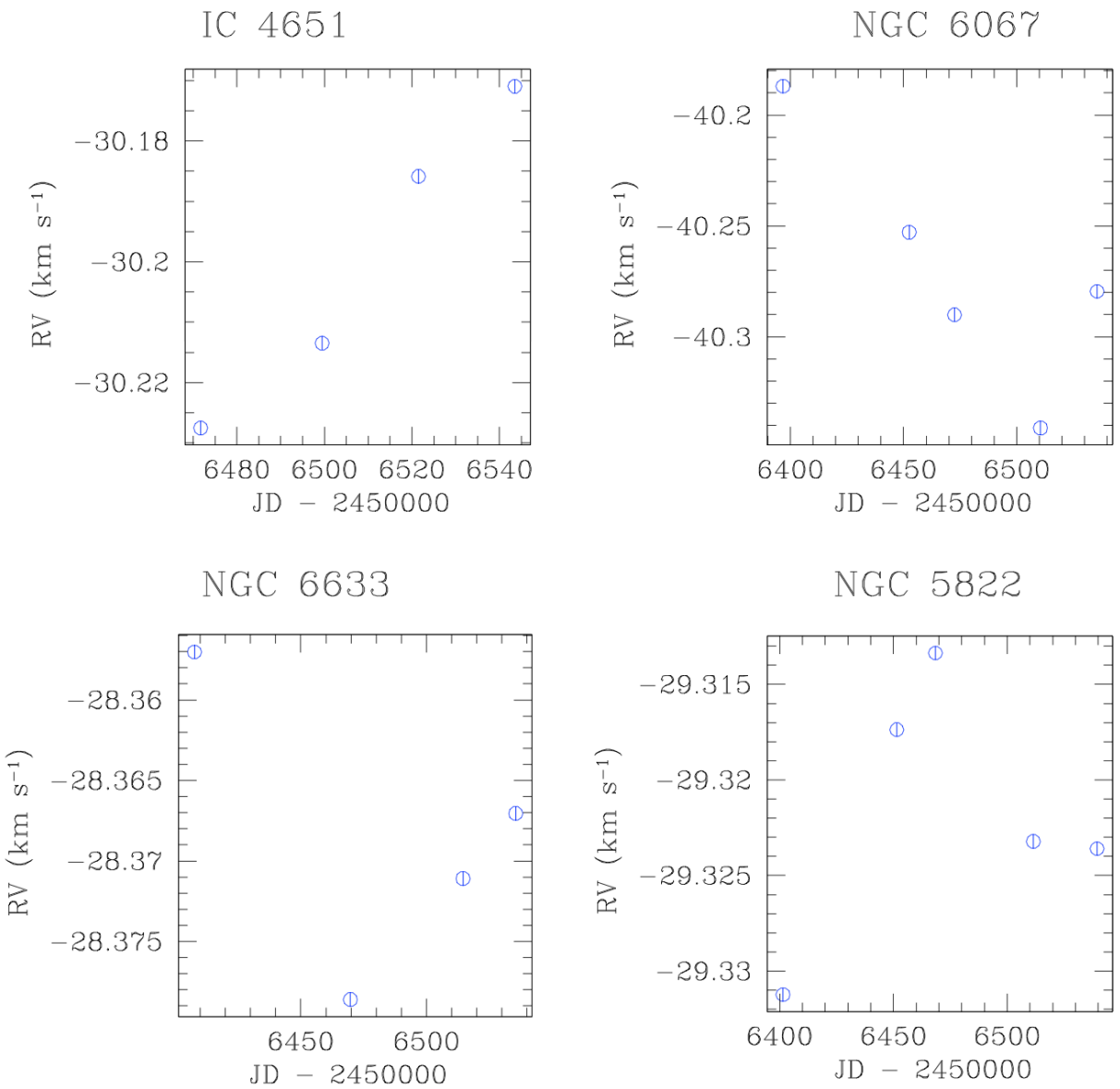
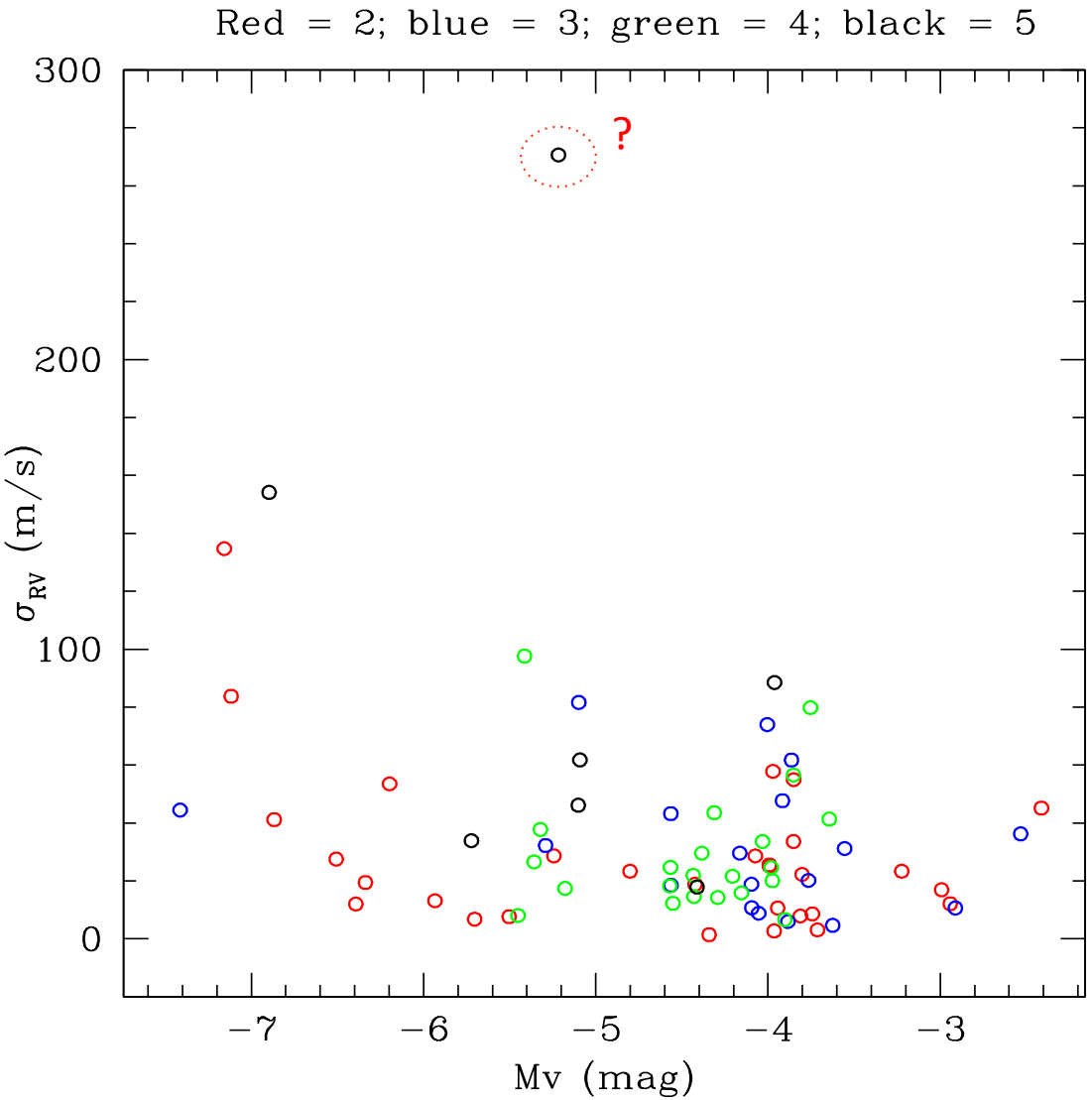


Fig 1: Radial velocity as a function of time for 4 stars in 4 different OC from our sample.

Results



Clear trend is visible

Fig 2: RV variability as a function of the stellar magnitude for the stars in our sample.

Results

- **Spectral Synthesis**
  - ✓ 65 stars with **2, or more**, observations & **RV variations**
  - ✓ **MARCS** atmosphere models;
  - ✓ Spectral Synthesis tools: **Turbospectrum** (Alvarez & Plez 1998)
  - ✓ Solar abundances (Asplund, Grevesse & Sauval 2005)
  - ✓ Atmospheric parametrs (T_{eff}, log *g*, *ξ*, [*Fe*/*H*]) from Canto Martins et al. (2011)

Conclusions

- ✓ Include P92 observations (Dez/13, Jan/14 & Mar/14)
- ✓ Check if the RV variations are due to the **presence of a sub-stellar companion** (planet or binary system) or some **intrinsic component** to the star
- ✓ Chemical Abundances (OI, Si I, Na I, Mg I, Ca I, Ti I, Co I, Ni I, Zr I, La II and Cr I)

Soon, first release with the results in progress!!!