Rotation, age and activity of stars close to the Sun

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The properties of local stars nearby the Sun are crucial for the study of extrasolar planets both for the identification of the best targets where to look for new planets and for the characterisation and the study of the planets already detected.

One issue of interest, in particular, is the age of the target stars because the age of solar-type stars is related to the activity and then to the stellar noise. Furthermore an accurate age is crucial in order to understand the evolutionary status of the planetary systems, in particular those hosting Hot Jupiters (Hellier et al., 2009).

Recently an anomalous high activity of the target stars in Kepler field has been found, with a typical stellar noise about a factor 2 higher than expected (Gilliland et al. 2011). The stellar noise is matter of concern for the detection of low mass planets from space.

With the present study we investigate on the statistical properties of stars nearby the Sun and those projected in the Kepler field, in particular on the age and rotational distribution. In spite of many recent studies it is not clear if the Sun is a typical star, as concerning these properties, relatively nearby solar type stars.

We used three different sources: the original Geneva-Copenhagen catalogue (Holmberg et al. 2007, 2009), its revision by Casagrande et al. (2011), and Valenti & Fischer (2005).

The results depend on the selection of the temperature (or spectral type) of the stars because F stars present systematically younger ages and $v \sin i$ velocities rapidly increasing with the temperatures.

In Fig. 1 we present the distribution of ages from the whole catalogue of Holmberg 2009, where the age histogram distribution is plotted and compared to the age of the Sun (4.6 Gyr, red line on each plot). The median value (green dashed line) is about 2.4 Gyr, considerably lower than the Sun, while in the central panel the sample was limited to stars selected with the same criteria applied by Gilliland (2011) to the Kepler field. The median age is still lower than the Sun. In the right panel only solar stars (G type) have been plotted: this histogram shows a considerably older age, even older than the Sun. Similar trend is shown in the panel (b), where the Casagrande et al.

(2011) revised ages are used, and panel (c) where Valenti & Fischer (2005) data are presented. A provisional conclusion is that the median lower age in the Kepler field could be due to the inclusion of earlier type stars in the sample more than a peculiarity of the region. The Sun does not seem unusual, compared to the nearby field stars. This conclusion is similar to Chanamé & Ramirez (2012).

However the ages, in these catalogues derived from the isochrones, are uncertain because they are from main sequence stars where there is a degeneracy with the masses when are based mainly on luminosities and colours. A further check can be obtained comparing histograms with the *v*sen*i* rotational velocities of the star sample which is a well known independent indicator of age (and stellar activity) (Mamajek & Hillenbrand 2008).

In Fig. 2 panel (a) the *v*sin*i* histograms for the same three samples described in Fig. 1 are plotted using the *v*sin*i* from Holmberg et al. (2007). In panel (b) the *v*sin*i* values from Valenti & Fisher (2005) are shown. While the trend is similar to Fig.1, with a lower median velocity for the selected G-type stars, the Sun appears to be systematically slower than the sample stars. At present it is not clear if this difference is due to systematics in the measurements of the sin*i*. We know that there are some zero point differences between the catalogues and some deviations from linearity (Di Napoli, 2010), but if real, this difference could explain a higher noise for field stars as compared to the Sun. The slower rotation of the Sun, when compared to the solar type stars. if confirmed, could be due to a slightly older age or to a peculiarity of the Sun, but could also imply that the isochrone ages of the catalogue stars are a bit biased to older ages. Further studies are needed to clarify these points.

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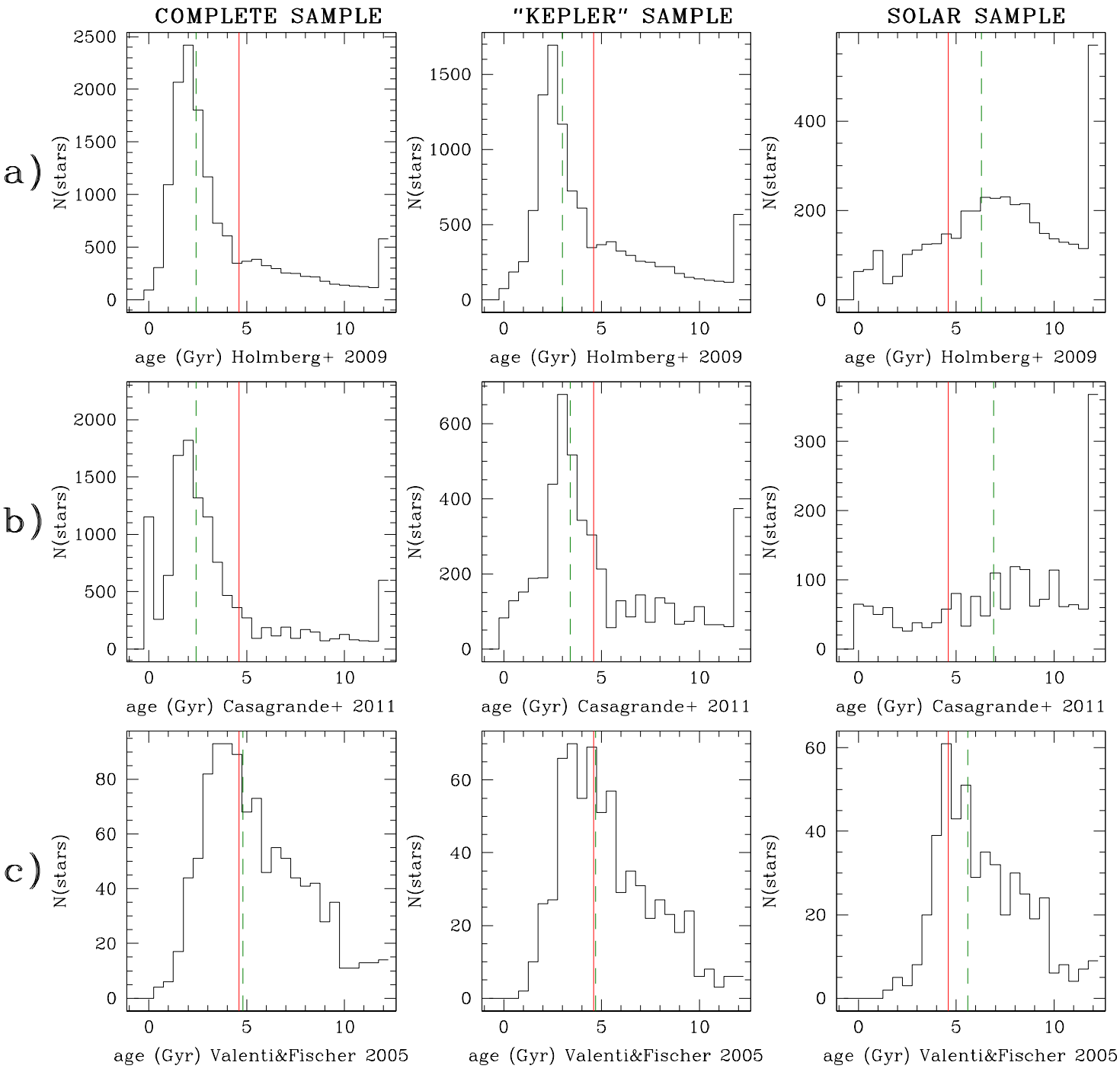
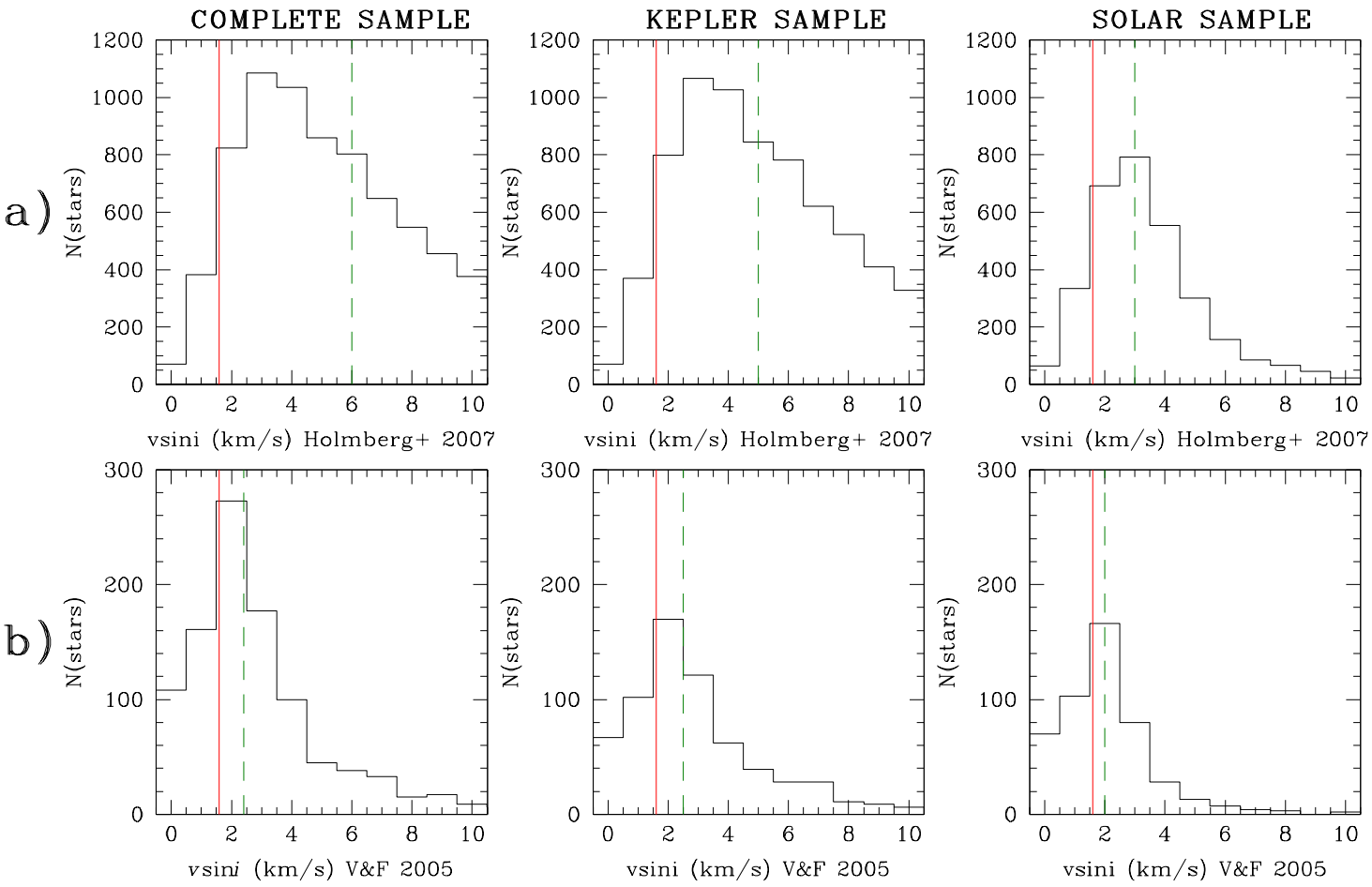

COMPLETE SAMPLE
"KEPLER" SAMPLE
SOLAR SAMPLE
a)
b)
c)
N(stars)
age (Gyr) Holmberg+ 2009
age (Gyr) Casagrande+ 2011
age (Gyr) Valenti&Fischer 2005


COMPLETE SAMPLE
KEPLER SAMPLE
SOLAR SAMPLE
a)
b)
N(stars)
vsini (km/s) Holmberg+ 2007
vsini (km/s) V&F 2005
0
200
400
600
800
1000
1200
100
300
2
4
6
8
10