IMPACT OF BINARITY ON THE 3 MAIN ASTROPHYSICAL OBJECTIVES OF CHARA/SPICA

Group Multiplicity:
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• Before 2024: Remove binaries from sample used for construction of SBCR (for PLATO)
• Except for: O-type and early B-type stars: well known procedure that be able to treat binarity (not PLATO targets)
EXOPLANETS

• 1) Check for binarity
• 2) If exoplanet in binary → orbit follow-up (future)
If star is an asteroseismic binary

1) Calibrating seismic relations
   - CHARA/SPICA orbit + (parallax OR RV) → $M_A$, $M_B$
   - CHARA/SPICA two diameters + parallax → $R_A$, $R_B$
   - Maybe a few valid targets (before PLATO)
   - Orbit follow-up with PLATO seismology

2) CHARA/SPICA observations can flag for multiplicity
   (for binaries that have not already been detected)
GENERAL

• General
  • Pierre’s catalogue (GAIA + Hipparcos) → Benchmark stars
    • M/R separated if follow orbit
    • → selection of candidates
  • Calibrators
    • Multiplicity is a problem
    • For V < 7 and θ < 0.1 mas → about 100 stars available for CHARA/SPICA: BIII or BIV stars that should probably not be multiple
    • GAIA can help to remove some binaries from the calibrator catalogue
    • CHARA/SPICA will also clean this sample → all these stars have to be in target list
CONCLUSION

• In most cases, binarity is a plus
• Most identify cases are not specific to one of 3 scientific objectives
• Binarity : scientific case for CHARA/SPICA ?!
Hip-Gaia proper motion anomaly and binarity of Hipparcos stars

P. Kervella, F. Arenou, F. Mignard, F. Thévenin
Single star

Hipparcos

Gaia DR2
\[ \Delta \mu_{G2} = \mu_{G2} - \mu_{HG} \]

\[ \Delta \mu_{H} = \mu_{H} - \mu_{HG} \]
• Sensitivity in mass and orbital radius?

\[
v_1 = \sqrt{\frac{G m_2^2}{(m_1 + m_2) r}}
\]

\[
\frac{m_2}{\sqrt{r}} = \sqrt{\frac{m_1}{G}} v_1 = \sqrt{\frac{m_1}{G}} \left( \frac{\Delta \mu [\text{mas a}^{-1}]}{\sigma [\text{mas au}^{-1}]} \times 4740.470 \right)
\]

\[
\sigma(\mu) = 242 \mu \text{as a}^{-1}
\]

\[
\sigma \left( m_2^\dagger \right) = 0.040 M_J \text{ au}^{-1/2} \text{ pc}^{-1}
\]
we have to adopt model values of the masses of the two stars
the center of mass of stars A and B. In our simplified approach,
use these two values to determine the mean for both the Hipparcos and GDR2 catalog positions, and we
Kervella et al. 2016b
ing an a priori estimate of the masses of the two stars (see, e.g.,
mean PM has been subtracted to compute the PMa.
the orbital velocity of each star projected on the direction of their
notice this e
spond simply to the tangential orbital velocity vector. We clearly
PM of the center of mass, then the derived PMa does not corre-
Hipparcos and GDR2 epochs is not negligible compared to the
In other words, when the orbital motion amplitude between the
does not correspond any more to the PM of the center of mass.
mean PM between the Hipparcos and GDR2 epochs therefore
considered as being close to the photocenter, as this is the case
When
behavior in terms of PMa as the binaries for which
nents are massive and spatially resolved by Gaia have a di
The gravitationally bound binary systems for which both compo-
4.6. Resolved binaries with stellar mass companions
It is possible to compute the PM of the center of mass, us-
Fig. 2. Observing window smearing

\[
\begin{align*}
\mu_{HG} &= \mu_1 + \mu_2 + \mu_{PMa}, \\
\mu_{PMa} &= \mu_{PM} - \mu_{PM,CM}, \\
\mu_{PM,CM} &= \mu_{PM} - \mu_{PM}^{\text{obs}}.
\end{align*}
\]

It is the case that the component of the PM vector of
Fig. 3. GJ 338 are presented in Sect.
from the sensitivity limit of Hipparcos and the saturation limit of Gaia
sample as a function of the primary mass
Fig. 3) are shown as hatched areas, considering the mass-luminosity
\[ R = \left( \frac{M}{M_\odot} \right)^{0.5} \]
}\]
\[ M_\odot \]
\[ P \]
\[ \delta t \]
\[ P/\delta t \]
\[ |V| \]
• β Pic: position and μ imprecise in Gaia DR2, but PMa of Hipparcos ok (article Snellen & Brown 2018, Nat. Ast.)
Example: Ross 154 (M3.5V)

Parallax:
Hip2  1991.250  336.720 (2.030) mas (observed)
GDR2  2015.500  336.152 (0.072) mas (observed)

Measured PM vector in ICRS frame:
Hip2  1991.250    +637.020 ( 2.800)     -191.640 ( 1.700) mas/a
GDR2  2015.500    +639.344 ( 0.143)     -193.659 ( 0.121) mas/a

Computed (µalpha,µdelta) mean angular PM vector in ICRS frame:
GDR2-Hip2  2003.375    +639.499 ( 0.068)     -193.878 ( 0.056) mas/a

Computed diff. PM vector in ICRS frame:
Hip2-G2H2  1991.250      -2.361 ( 2.801)       +2.225 ( 1.701) mas/a = (-0.8,+1.3) sig
GDR2-G2H2  2015.500      -0.155 ( 0.159)       +0.220 ( 0.133) mas/a = (-1.0,+1.7) sig

Transverse velocity residual norm H2-G2H2  : 45.75 (46.21) m/s
Position angle of vel. residual H2-G2H2  : 313.31 (31.69) deg
Delta H2-G2H2 PM anomaly SNR               : 0.99

Transverse velocity residual norm G2-G2H2  : 3.79 (2.92) m/s
Position angle of vel. residual G2-G2H2  : 324.81 (27.73) deg
Delta G2-G2H2 PM anomaly SNR               : 1.30
Long periods

![Graph showing efficiency ζ vs. P/δt_{HG}](image)

- **Efficiency ζ**
- **3 δt_{HG}/P**

The graph illustrates the relationship between efficiency and the ratio of period to homogenization time, highlighting the long periods aspect.
• **Proxima:** $\mu_{HG} = 3859.110 \pm 0.069 \text{ mas a}^{-1}$
  $\Delta v \text{tan,G2} = 2.7 \pm 1.5 \text{ m s}^{-1}$