When size matter

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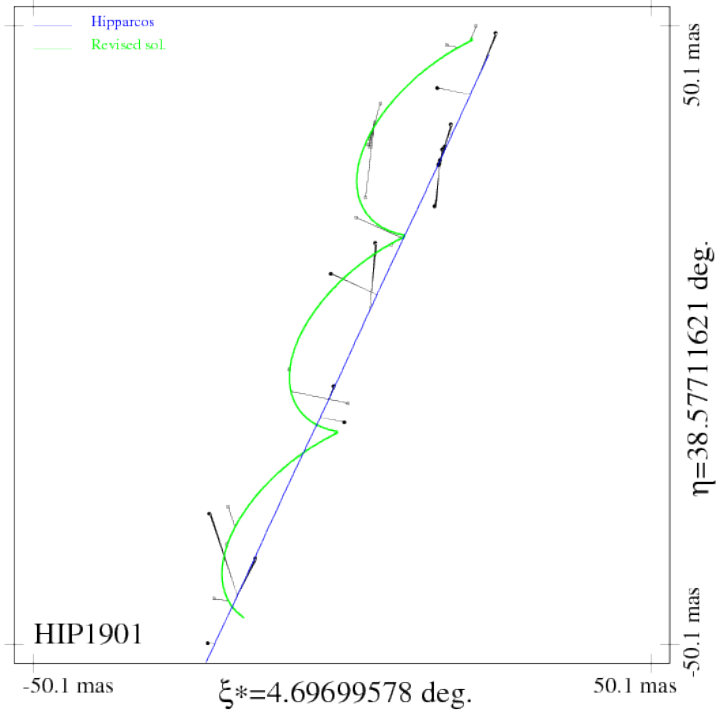
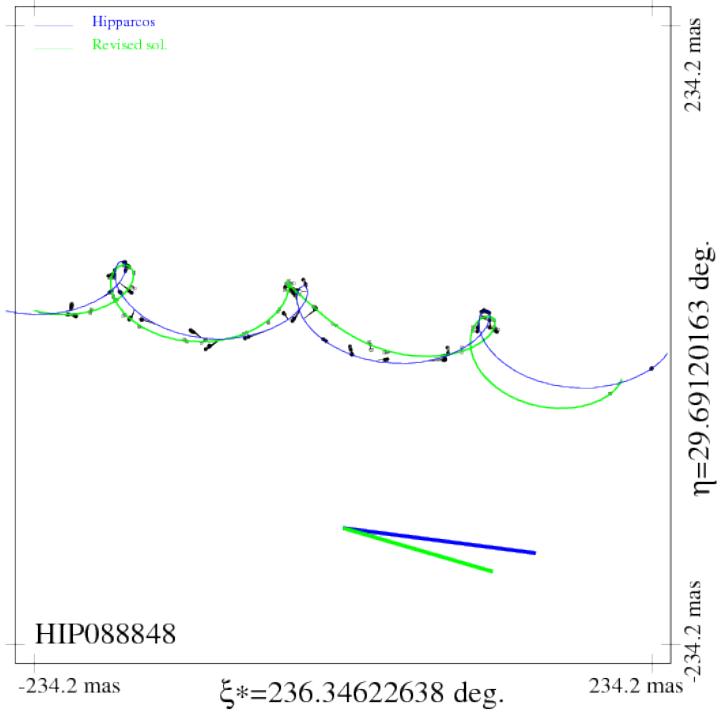
Why is an NSS-module necessary?

Astrometrists' point of view: because they affect ϖ and μ.





R And (HIP 1901):

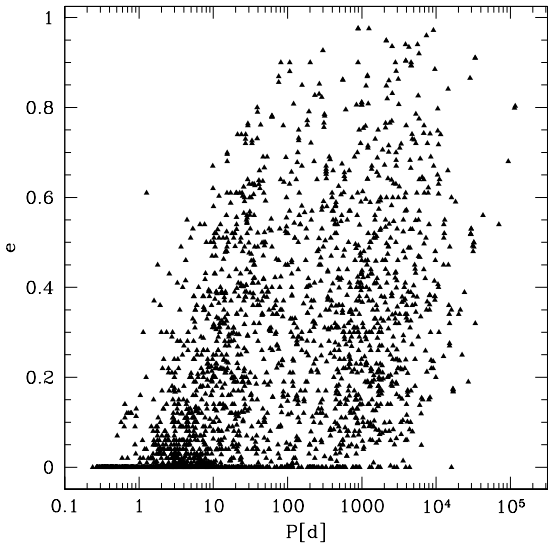
- Hipparcos parallax: -0.06 ± 6.49 mas
- Revised parallax: 6.96 ± 3.63 mas

V815 Her (HIP 88848):

- Hipparcos proper motion: $(138.07, -18.58)$ mas/yr
- *Binary* proper motion: $(106.59, -30.84)$ mas/yr

Why is an NSS-module necessary?

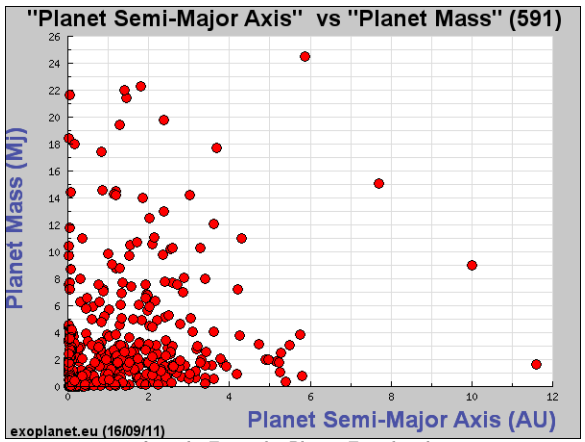
Astrophysicists point of view: because NSS are essential!



(e,log P) diagram from SB9

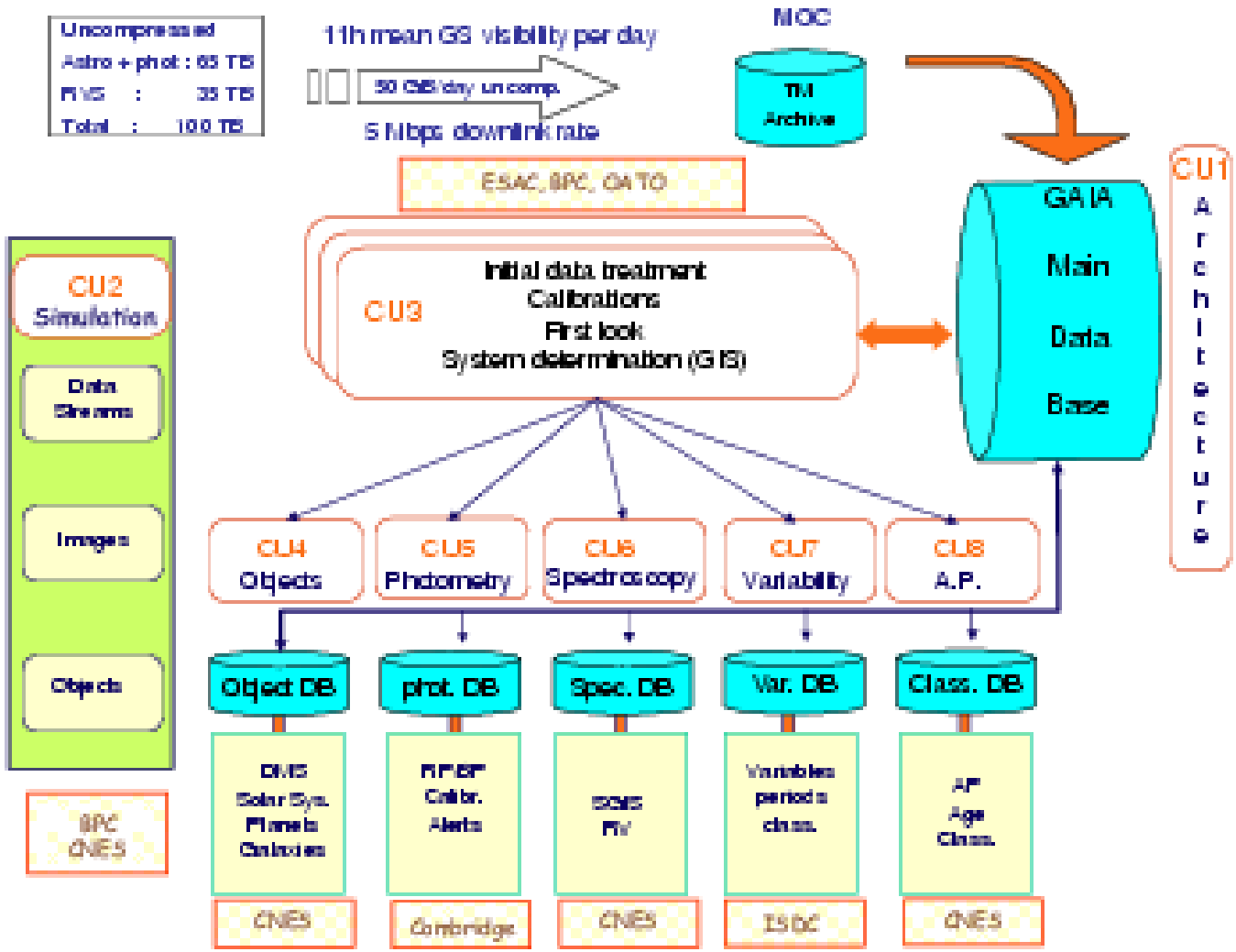
Instead of just (e, $\log P$) diagram with all known orbits, how does it change over the HR diagram? Right now, too few points per grid cell.

Every RV-based extrasolar planet lacks the orbital inclination required to derive its actual mass instead of just a lower bound for it.



from the Extrasolar Planets Encyclopedia

Object processing in DPAC pipeline



NSS in DPAC pipeline

Detectable NSS result in an *outlying* behaviour in at least one earlier segment of the pipeline:

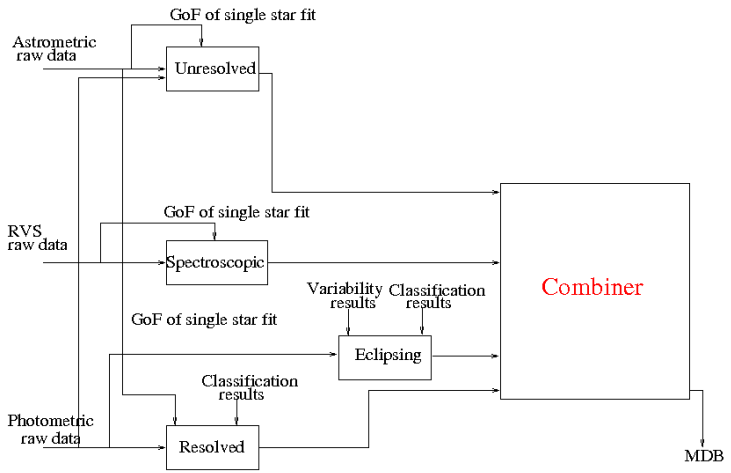
- CU3 : poor single star (5-parameter) fit
- CU5 : poor single PSF/LSF fit
- CU6 : excessive departure from the constant RV assumption
- CU7 : photometric variability resulting from eclipses

NSS further processes whatever object matches at least one of these criteria.

DU432-437 : unresolved NSS

- DU433 : resolved NSS
- DU434 : spectroscopic NSS
- DU436 : eclipsing NSS

DU439 in charge of combining these solutions.



What to do with detected NSS?

Default processing ⟷ Criterion? ⟷ Binary handling

The optimal criterion is a compromise between:

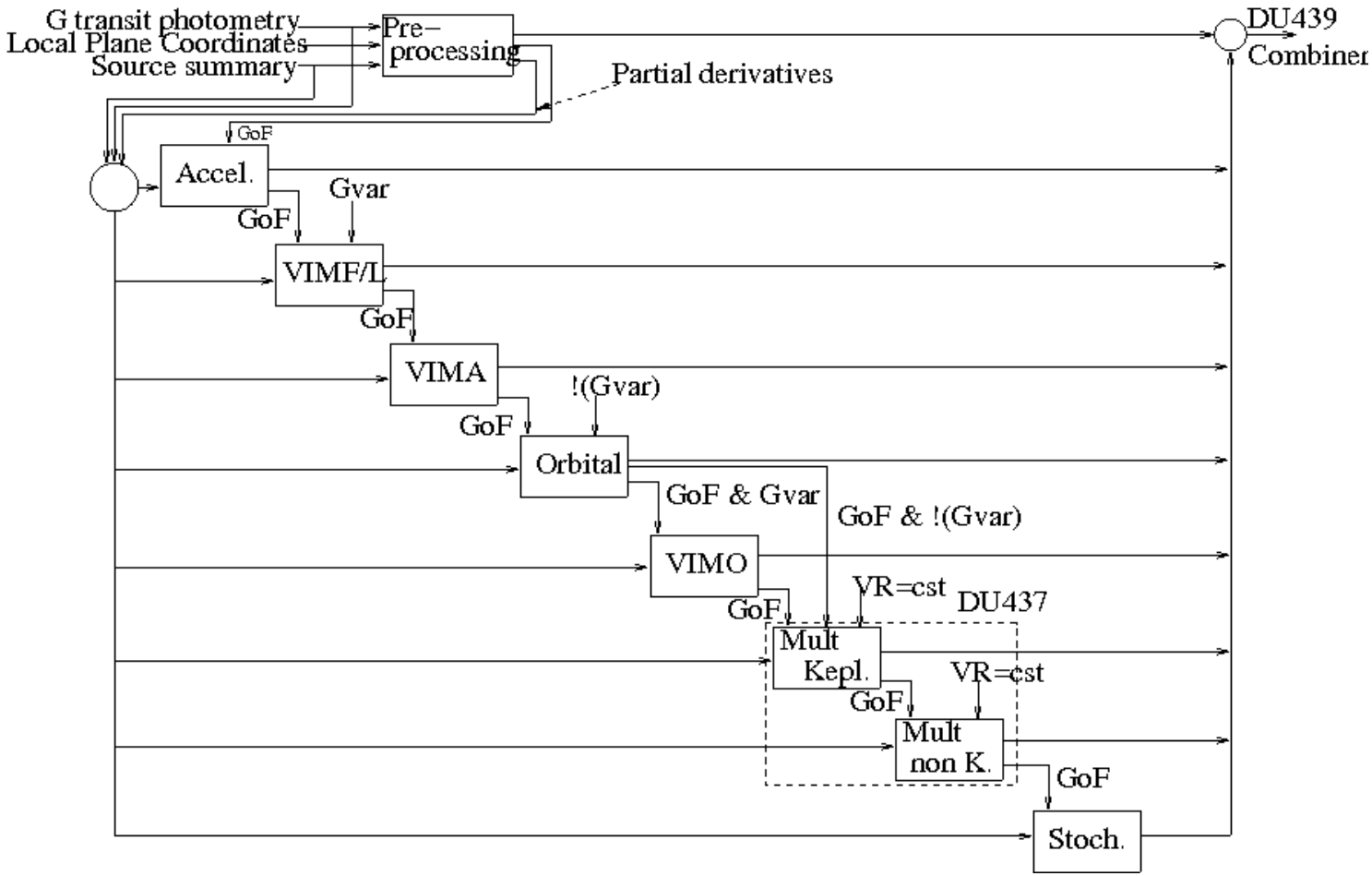
- maximizing the scientific return (e.g. avoiding HD 209458-like situations with Hipparcos),
- minimizing the computing time ($60\,10^6$ AB would take 200 days on today machines with the present code).

A priori versus *a posteriori* assessment:

- a priori test: there is no need to call the shell task (i.e. the single star fit is good enough);
- a posteriori test: there was no need to call the shell task (i.e. the orbital model is not worth keeping).

NSS modus operandi

Underlying assumption: Stop as soon as the model fits the data well enough.



NSS final product

Depending on the number of CU where the object pops up, the combined model parameters include some or all of the following:

- Reference position
- Parallax
- Proper motion
- Systemic Velocity
- Orbit size and orientation
- Eccentricity
- Period
- Periastron time
- Mass function, mass ratio or individual masses
- Reference flux
- $\log g$, T_{eff}, fill factors

+covariance matrix of the parameters

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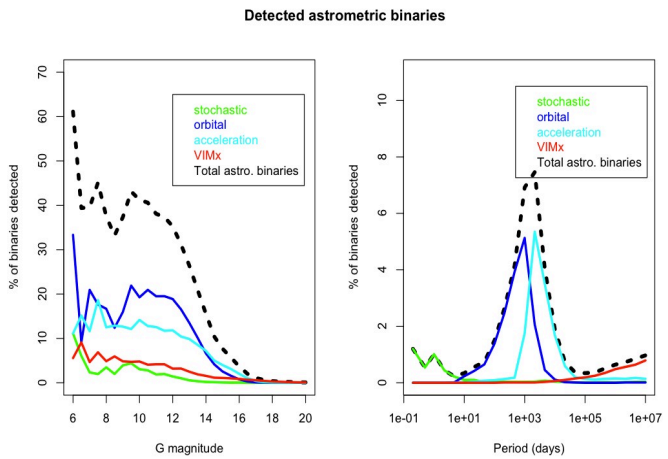
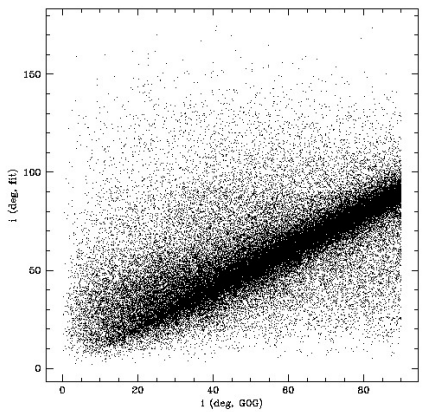
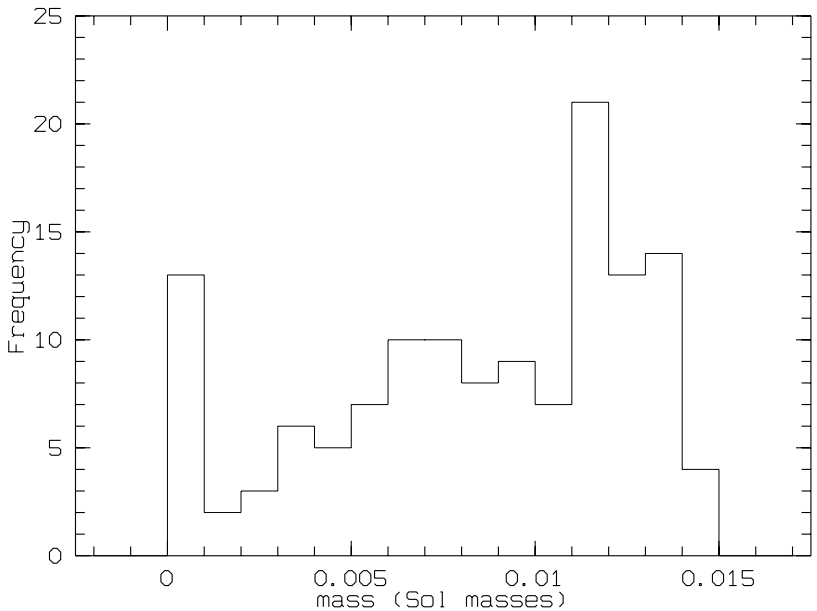
How ready and reliable is NSS?

NSS assessed on a simulation of 10M objects with state-of-the-art (Arenou 2011) statistical distributions of the parameters (binary probability, multiplicity ratio, semi-major axis, . . .)





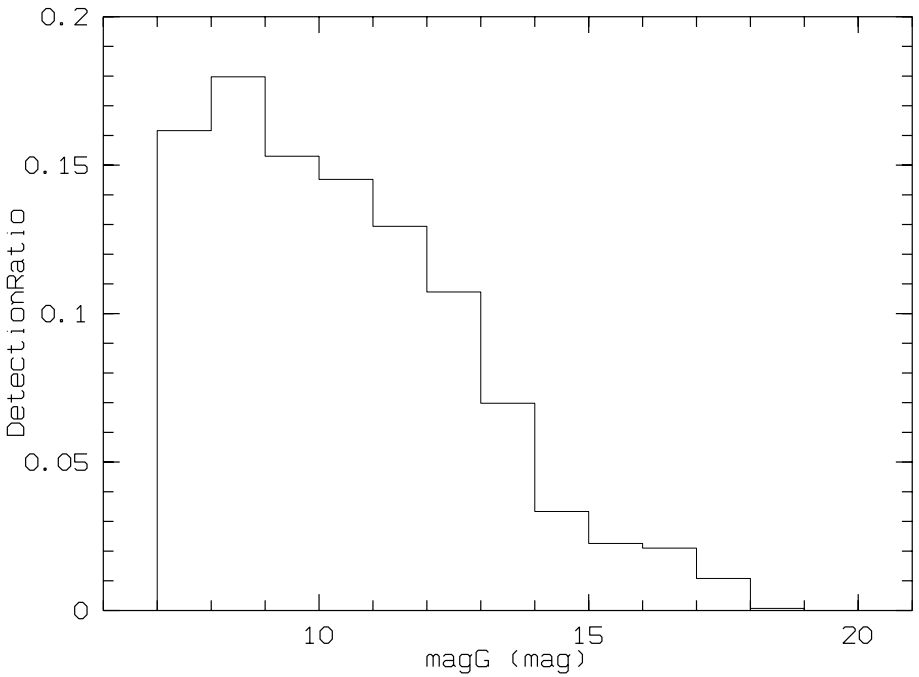


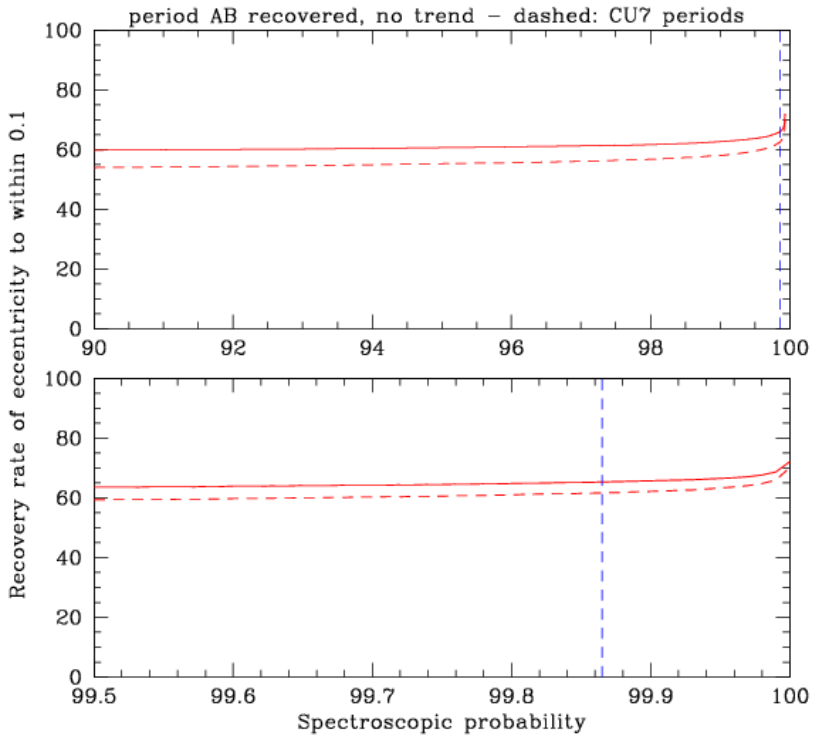
Extrasolar planets:

- ∼10 000 astrometric orbits
- ∼60 000 astrometric detections

versus 10M orbits of binaries.

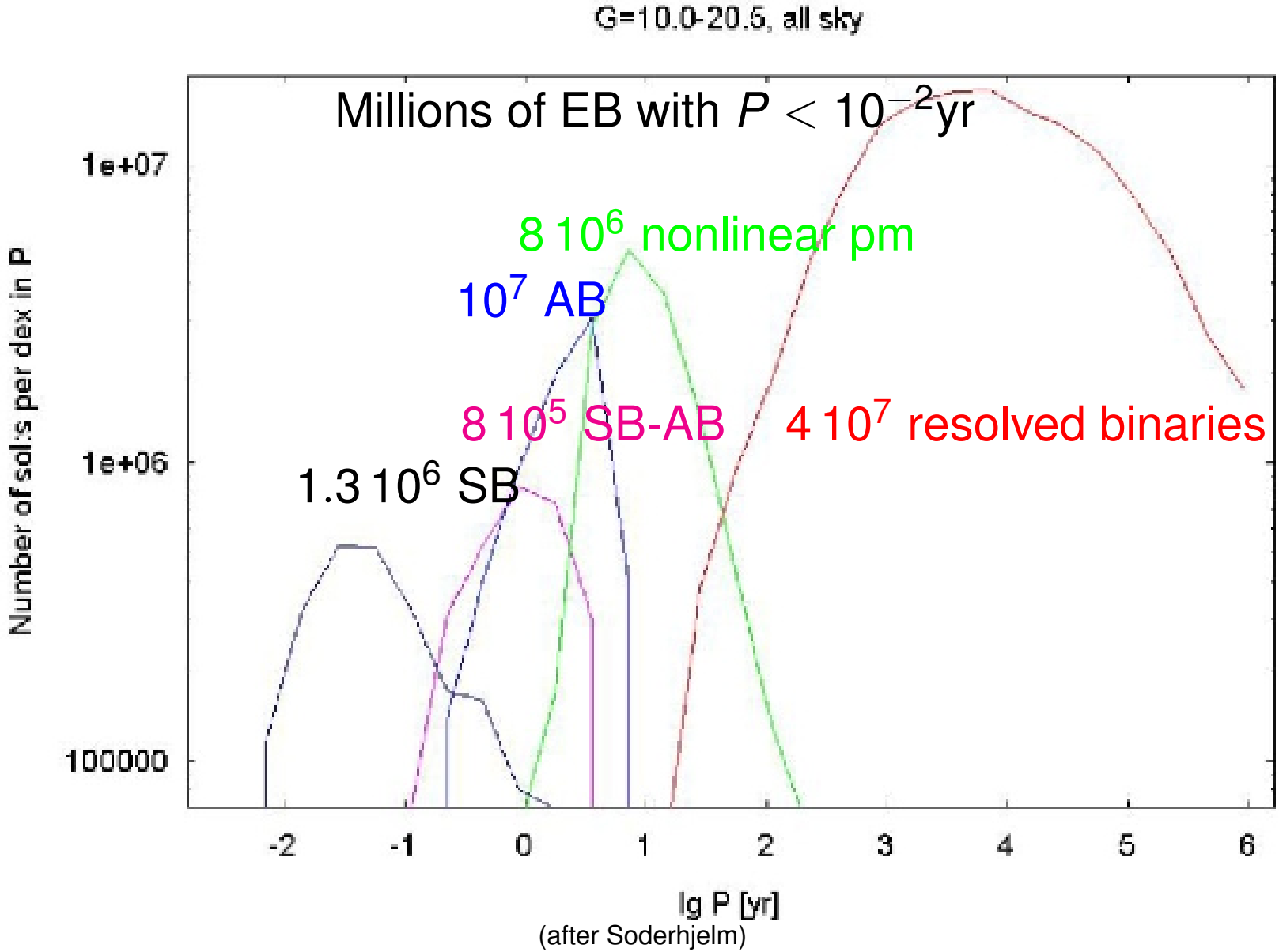
How ready and reliable is NSS? (c'tnd)





Unlike astrometric NSS, spectroscopic and photometric signatures are not distance dependent: 6M and 1.5M orbits respectively.

Gaia – expected results on binaries



(after Soderhjelm)

Conclusions

- Someone's garbage can be Science for others.
- All newly discovered HIP binaries should have their data processed accordingly.
- Do not push the garbage recycling too much, beyond the specs. Remember the Hipparcos-planets controversy.
- Non-single stars cannot be ignored and will be subject to a dedicated reduction.
- In terms of numbers (at least), all existing catalogues superseded by Gaia outcome.
- Nevertheless, be ready for follow up observations!

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