Some Thoughts on Astromesics

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Thoughts …

As to the/a SIM/GAIA (SIGA; sounds better than GASI) collaboration.

It seems to me that there are 4 ways to approach maximizing the science return for SIGA,

-1) Form GAIA’s perspective, what is it that SIM needs to do/be so as to maximally complement GAIA’s work
-2) From SIM’s perspective, what is it that GAIA needs to do so as to maximally enable SIM’s operations
-3) From the perspective of an astrophysicist with long-term vision
-4) But overriding these issues is the questions as to what kind of data astrophysics needs in the post-SIGA world to make headway.

GAIA perspective: Several obvious things come to mind:

1A) follow-up on stars too bright for GAIA

1A1) It would be really good to download the data for the saturated stars. Use the largest postage stamps possible or even cut out pieces away in cross-scan direction. These stars are important, even if much poorer astrometry is achieved. See #3 below

1B) follow-up on stars so faint that the S/N(PLX) is _just_ too small for interesting results.

This is the case for: a) the most metal poor stars (in eclipsing binaries), b) the most metal-rich stars, c) the lowest mass stars, d) the highest mass stars, e) (halo) stars with the largest proper motions, e) the most distant stars in the Milky Way (at largest Galactocentric radius & well sampled in azimuth), f) MW velocity field tracers in the inner Galaxy, g) the much-underrepresented Galactic long-period Cepheids that GAIA will discover, h) any other type of rare objects such as long-period variables, central stars of planetary nebulae, central stars of SN remnants (if any), population-II Cepheids (any type of object in the instability strip), i) the most luminous stars (supergiants of all color: identify? SN precursors), j) ...

@2) SIM perspective

2A) quick release of GAIA intermediate (and final) data products to enable early incorporation of the GAIA results in SIM follow up. This early info is not limited to astrometry: GAIA spectroscopy will reveal many interesting objects for SIM follow up.

2A1) For studies of the rarest objects (see #1B)

2B) use the GAIA data to re-analyze the historic (20th Century) astrometric data. See #3A and #3B

@3) Long-term astrometry

3A) The "most stable" GAIA stars down to V˜14 (i.e., w/o indication of acceleration) should be used to redetermine the ICRF and backtrapolate these stars back to late 1880s.

The goal is to help constrain long-period systems (planets, brown dwarf and stars). This can only be done with superb 21th century astrometry (SIGA) and the best possible 19/20th century astrometry (including Hipparcos)

3B) The methodical goal is to re-reduce all existing astrometric catalogs (much like as done for the Tycho-2 catalogue) to eliminate the remaining astrometric/zonal errors as much as possible.

This should also be done for Hipparcos to eliminate any doubt about remaining zonal errors.

In most of these older catalogs, the systematic errors are significantly larger than the internal errors. I guesstimated that errors on the AC (1907) and POSS (1950-1990) data can be reduced by a factor of two. [For example the re-reduction of the AGK2 data onto the Hipparcos-based ICRF reduces the errors from ˜200 mas to ˜70 mas].

@4) Beyond SIGA:

Paradigm shifts based on SIGA data in at least two fields are fairly easily to predict.

4A) Galactic Dynamics (of the disk). Bottom line: reliable stellar ages are required for vast numbers of stars.

Contrary to current procedures, after SIGA dynamicists will need to include the ages of their test particles (stars) in a meaningful manner. Depending on the age of the star, it was born at a time that the Galactic potential was different from what it is now.

For example, the Sun was born about 1/2-way the age of the thin disk, so (with ˜constant star-formation history), the stellar disk at that time was 1/2 as massive. Everything else being the same, the circular velocity would have been ˜SQRT(2) times smaller (maximum disk assumed). Over time, as more gas falls gradually into the Milky Way, the potential well (due to the stars) deepens gradually, and the orbit of the stars change adiabatically.

One might be able to unravel this (figure out what happened), but ONLY if reliable stellar ages are required for vast numbers of stars.

4B) Calibration of stellar structure & atmospheres will be enormously improved such that the requirement for (4A) will be rather well met.

To seriously challenge stellar models, one needs to measure (accurately [<˜ several percent]) the fundamental stellar parameters: Mass, radius, Teff and [Fe/H]. Today, at most a few hundred stars may meet part of this requirement.

The radius requirement eliminates traditional test cases such as open/globular clusters as they do not have, generally speaking, stellar radii available. UNLESS optical interferometry can generate those radii.

The post-SIGA GOLD STANDARD will be eclipsing binaries (EBs) for which all those parameters CAN be established. The consistency check is that both components should have the same age (&metallicity).

The enormously large number of EBs (˜400,000 with PLX <1%) guarantees that a wide range in properties will be calibrated: masses, metallicities, ages and separations (to study/eliminate proximity effects)