Roman Early-Definition Astrophysics Survey Opportunity

Galactic Roman Infrared Plane Survey (GRIPS)

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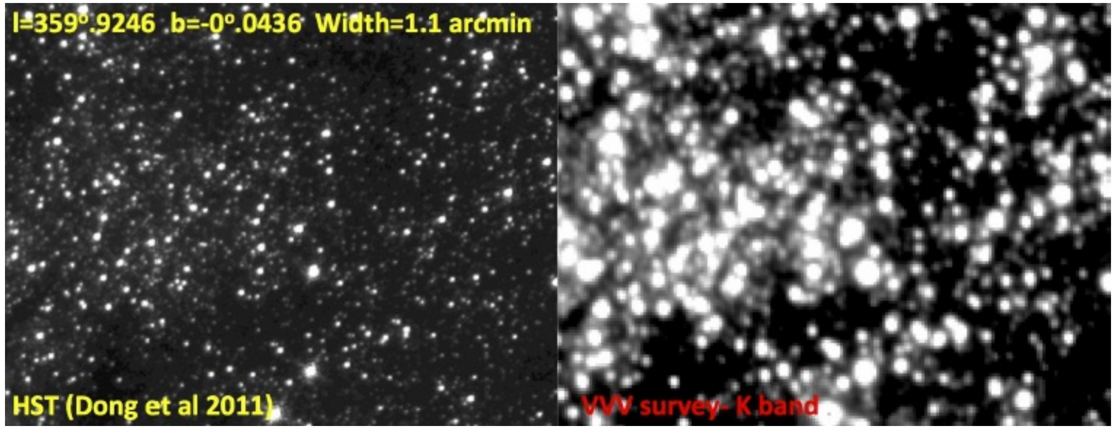
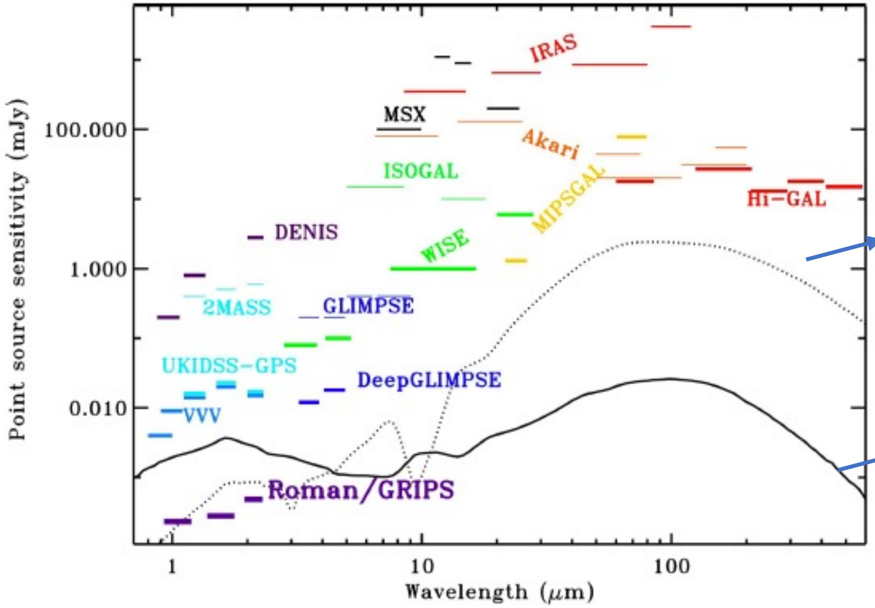
Motivation

Roman will be uniquely positioned to perform a survey of the Galactic Plane:

High angular resolution: of the inner Galactic Plane, only 2.8 deg have been covered by HST. Roman will allow for the **identification of 120 billion sources,** a significant fraction of the Milky Way's stars. For comparison, this area contains only 0.38 billion sources in Gaia eDR3.



Sensitivity: With a K-band sensitivity limit of 22.85 (Vega) mags and assuming no extinction/source confusion, Roman/GRIPS can reach MKs=8.25 (M5V) for sources at the distance of the Galactic Center and MKs=12.5 (mid L dwarfs) for sources in M8 and M20. A solar type star could be detected on the far side of the Galactic disk, even with 2-3 magnitudes of absorption.



Mapping Speed: will allow for a significant fraction of the stars in the Galaxy to be covered in a uniform way, a crucial requirement for studies of Galactic structure.

Scientific Rationale

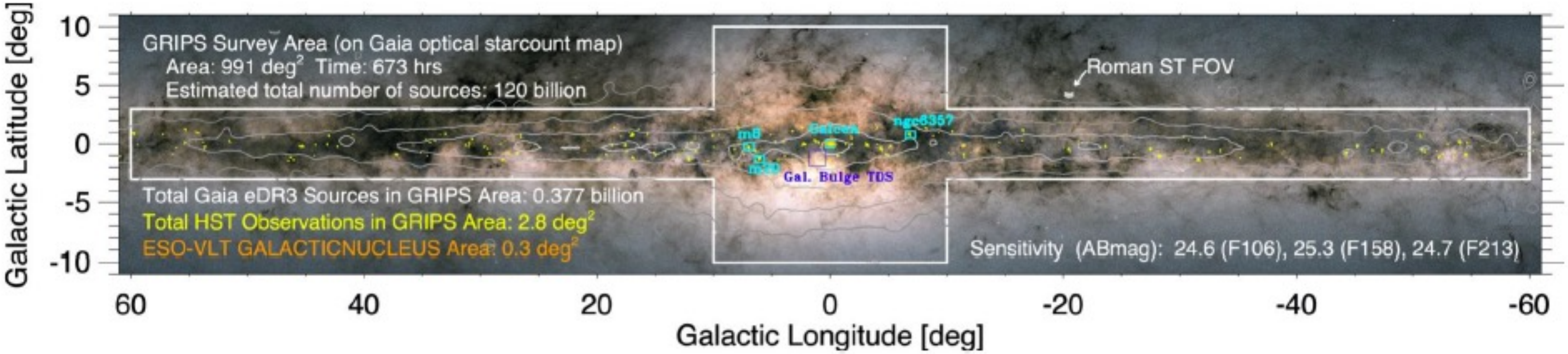
Roman is uniquely suited to deal with the confusion and extinction prevalent in the plane of the Galaxy. **A Galactic Plane survey was one of five programs specifically endorsed by the Science Definition Team (SDT) in the WFIRST Interim Report (Green et al 2012).**

- **Unresolved Stellar populations:** GRIPS will enable studies of previously unresolved stellar populations (stellar clusters in star-forming regions, globular clusters).

- **Structure of the Galaxy – bulge / spiral arms:** Red clumps and YSOs can be surveyed out to a greater volume of the disk allowing the rewriting of Galactic structure, particularly the spiral arms and the central Galaxy where source confusion has blocked progress.

- **Stellar Initial Mass Function & 3D dust maps:** GRIPS will enable studies of the stellar initial mass function down to lower mass limits in sites across the Galaxy, and provide significantly more "background" sources for the construction of 3D dust maps.

Possible Observational Outline



- **Coverage:** -60 < l < +60 deg, |b| < 3 deg (inner Galaxy + bulge) - ~1000 deg^2 total
- **Filters:** F106, F158, F213 (roughly, JHK)
- **Integration Time:** 55 sec / filter → minimum depth: 25.5 mag, 25.3 mag, 24.7 mag (F106, F158, F213, respectively)
- **Dithers:** one primary dither (filling detectors gaps + cosmic-ray removal) and two secondary dithers (F213, accurate astrometry)

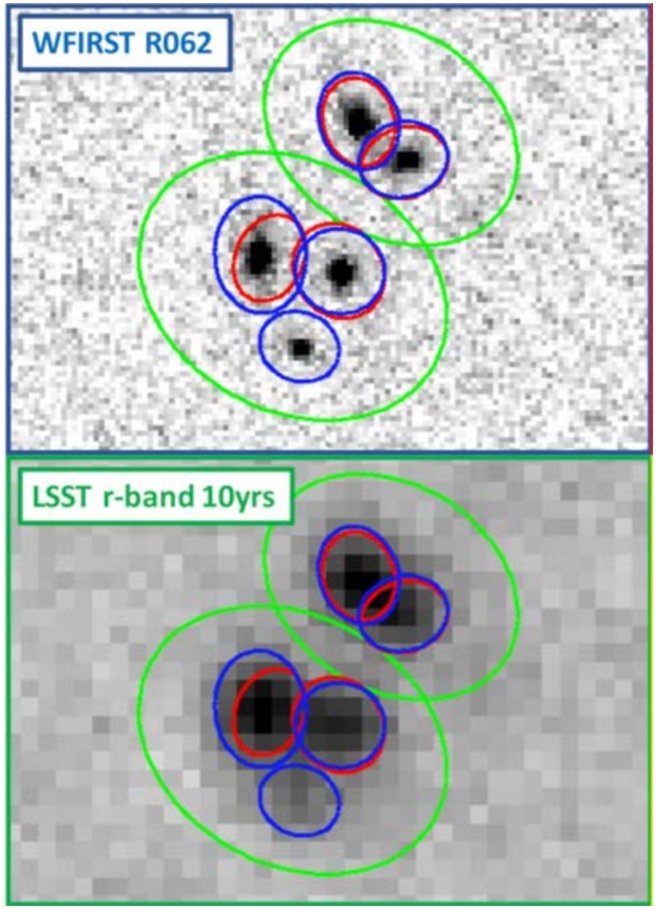
Total: 673 hrs

Why an early survey ?

- **Setting the Stage:** Defining the survey early will allow us to build not only the most powerful survey to address different science cases on its own, but also a well-crafted initial design to enable optimal expansions in epochs, spatial coverage, wavelength coverage by subsequent guest investigators.

- **Proper Motion Studies:** A single-pass survey of the Galactic Plane early in the mission would enable subsequent passes later on, largely surpassing what can be obtained by simply combining Roman and, e.g., 2MASS, with a 25-year baseline, therefore bolstering the characterization of stellar proper motions in regions inaccessible to Gaia, notably in the complex orbital structure of the Galactic bar(s) and nucleus.

- **Development of a Crowded-Field Forced Photometry Pipeline:** The development of PSF forced photometry pipelines able to operate in heavily crowded fields is required given the resolution of ground-based observations. This activity will complement efforts such as the Joint Survey Processing (Chary et al. 2020), which is focused on lower source-density regions.



Green: *ground-based resolution r-band data (e.g. LSST).* ***Red:*** *Euclid-quality optical data.* ***Blue:*** *HST/ACS data (Lee & Chary, MNRAS, 2020, 497, 1935)*