GaiaNIR, our next astrometric mission (in the IR)

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Abstract: The All-Sky Visible and Near Infrared Space Astrometry GaiaNIR mission, built on Gaia principles, began his official journey on 2019 with the publication of the first white book. Two years later, on 2021, the ESA Science Programme Voyage 2050 selected the global astrometry in the near Infrared (NIR) as a key theme. The roadmap for the future μas astrometry in Europe is on the way! Peering through the dust, with a wavelength cutoff in the K-band, GaiaNIR will observe at least 5 times as many stars as Gaia. Furthermore, combined with Gaia and other space missions (e.g. Euclid and Jasmine) it will give a baseline of 25-35 years thus improving proper motions in a factor of 14-20 better that Gaia. With this potential accuracy, the dynamical evolution of the Milky Way will be traced looking at the inner bulge and bar and, at the same time, using traces out to 100 kpc with a potential accuracy of 2-3 km/s. Finally, GaiaNIR proper motions will also allow the study of massive local group galaxies. These are only examples of the extremely broad potential science cases of GaiaNIR, a mission that, as Gaia, will cover nearly every brach of astronomy.

GaiaNIR Timeline	
2016	ESA announced a call for innovative science ideas
2017	2017: ESA approves a technological study on the IR option
2019	A science case white paper was submitted to Voyager 2050
2021	Voyager-2050 identify 2 main themes: 1) Exoplanets that may host live; 2) Hidden regions of our galaxy in NIR (GaiaNIR)
2023-2024	TDI mode feasibility studies in IR ongoing
Q4-2025	I Workshop GaiaNIR-España (REG, CDTI, Industry) - TBC
2030 (TBC)	The missions will be selected when ESA issues individual calls
2045-2050	Mission launch and starting of scientific operations

Global (all sky) NIR (Gaia like μas) astrometry

- Wavelength range ~2500 nm (<800nm challenging)
- H and K bands up to mag 20, 5-6 more stars than Gaia
- ~2 billion common stars from Gaia with a 20 years' time gap would give proper motions 15 times better
- A radial velocity spectrograph is on study

Science cases

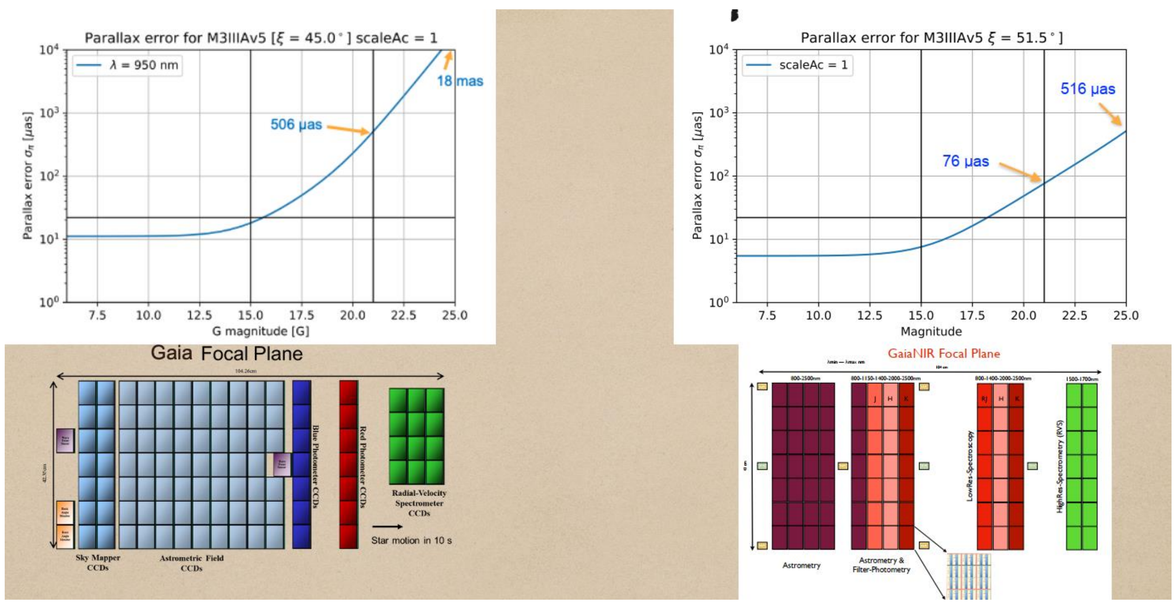
Among others (see Hobbs+2024):

- Dynamical important hidden regions of the galaxy: inner disk, bar perturbations, bulge
- Spiral arms mapping
- Exoplanets in dusty regions
- Obscured areas of star forming regions
- An expansion of the optical Reference Frame to the IR is really needed (Hobbs+, 2021)
- Wide binaries as proves of DM nature
- Many other: Brown Dwarfs, WD, free-floating planets, ….

GaiaNIR vs Gaia

Preliminary assessments on parallax and focal plane comparison

From Hobbs+2024:



Synergies:

- GALACTICNUCLEUS (led by IAA) NIRCam/JWST o HAWK-I/VLT
- NASA's Nancy Roman (2026): first epoch PM for GaiaNIR
- JASMINE (Japan, 2028), 100 pc Galactic Nucleus + Exoplanets
- Vera Rubin (LSST), much deeper than Gaia (mag~25)
- Others

The Spanish enrolment

To be launched around 2045, the Spanish Gaia community has already envisaged some potential contributions to the conceptual design task for the next decade. REG will take the compromise to organize the First Spanish Workshop on GaiaNIR. It is time to organize the Spanish community - scientist, engineers and space private companies - on this exciting endeavour.

Voyage 2050 White Paper

All-Sky Visible and Near Infrared Space Astrometry

Hobbs et al (2019): includes members from UB and CAB

GaiaNIR

Estimation of the Number of Sources Detectable by GaiaNIR

Draft

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affiliation: Universitat de Barcelona, ICCUB-IEEC
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issue: 1
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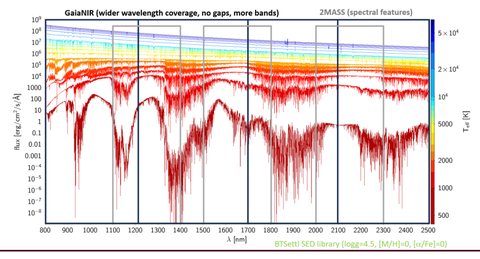
status: draft

Abstract: Counts of stars observable by GaiaNIR with different wavelength ranges are estimated using the GaiaSimu, the Gaia Univers Model simulator.

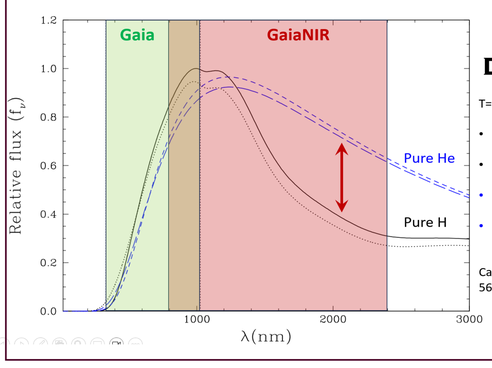
Photometric system optimization, preliminary studies (Carrasco et al., 2023)



Preliminary list of potential contributions

- To identify partners in the Spanish industry
- Instrument design (b, Photometric system)
- Science cases (inner disc, open clusters, time-domain alerts, exoplanets, ...)
- Simulators: row telemetry, image simulator, GaiaNIR GOG
- Onboard data treatment (envisaged to be complex)
- Ground processing (IDT, IDU... as did for Gaia)
- Managerial aspects (from experience)

Science cases studies: WD as GaiaNIR



WHITE DWARFS

T=4000K, logg=8.0

- Pure-H solid: with Lyman-α opacity
- Pure-H dotted: without Lyman-α opacity
- Pure He medium dashed: Bergeron+1995
- Pure He long dashed: Kowalski+2007

Carrasco et al (2014), A&A 565, A11, 16

Gaia + GaiaNIR and GaiaNIR uncertainties (Romero-Gómez et al., 2023)

Based on GaiaDR4 (5 yr) + 20 yr base line + GaiaNIR (5 yr), based on D.Hobbs (slides IAU2022)

√2 factor improvement in parallaxes

20 factor improvement in proper motions

We assume the same error model as in GaiaDR4

Parallax uncertainty (mas)

Proper motions uncertainty (mas/yr)