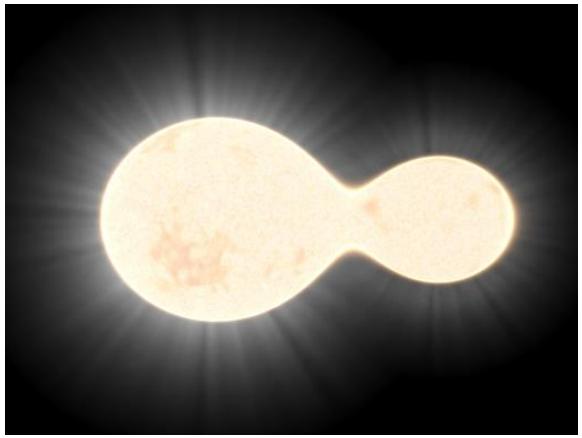
The Gaia catalog of hot subluminous stars

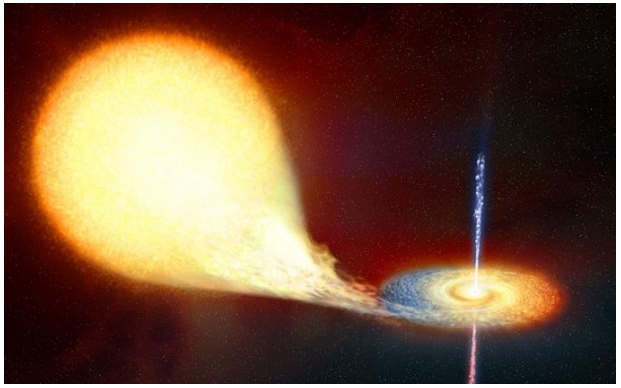
Stephan Geier

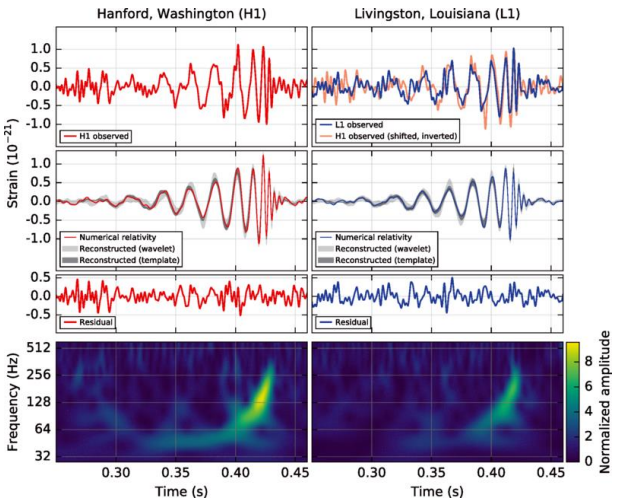
Stellare Astrophysik, Universität Potsdam

Most stars are not alone

Binary interactions are common

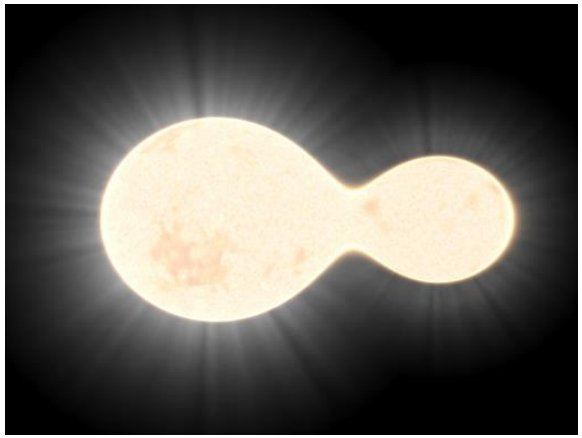


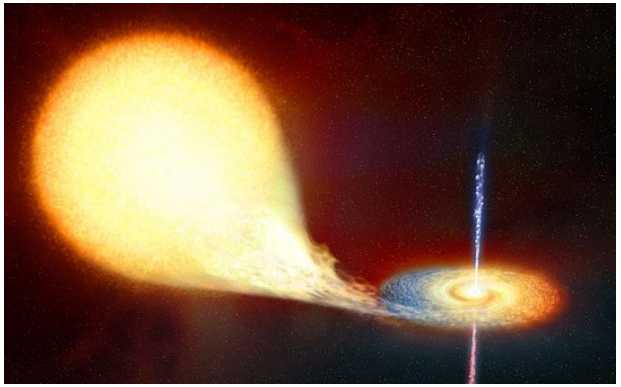


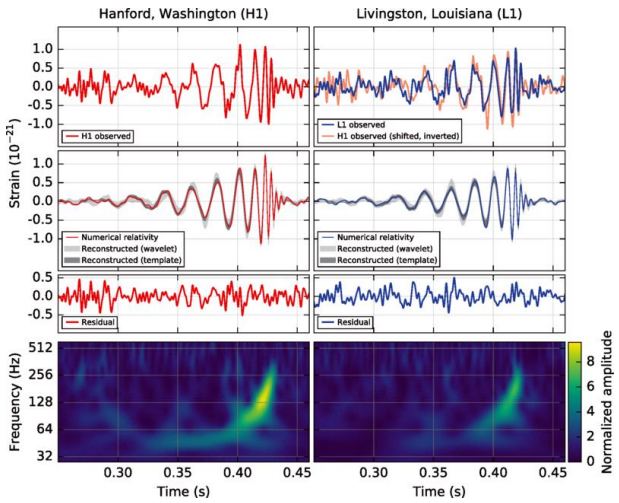


(ESA, ESO, NASA, Caltech/JPL)

Interactions are (too) short







(ESA, ESO, NASA, Caltech/JPL)

Interactions are (too) short

„Entscheidend ist,
was hinten rauskommt“

Helmut Kohl

Hot subdwarfs – too small and hot

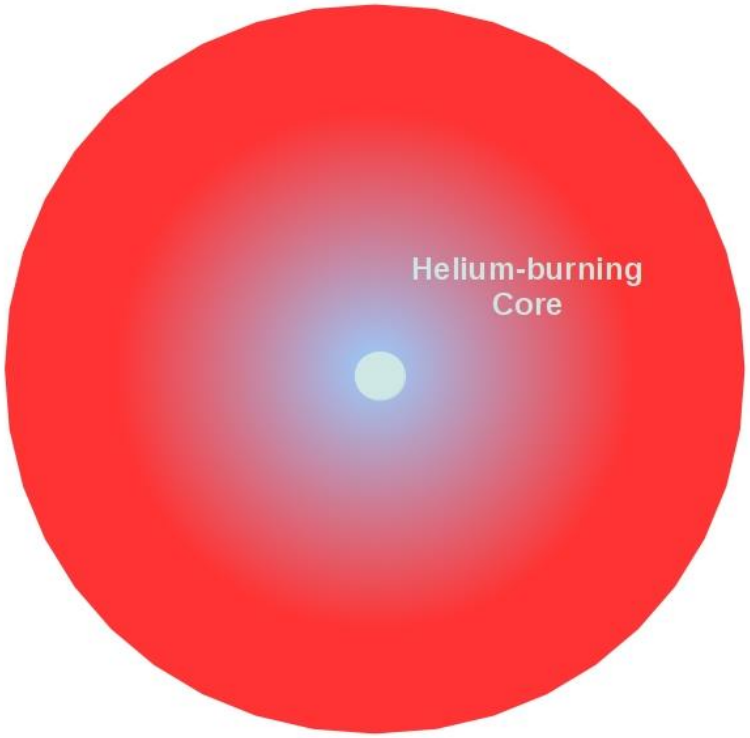
Sun

sdO/B

$M = 0.5\ M_O$

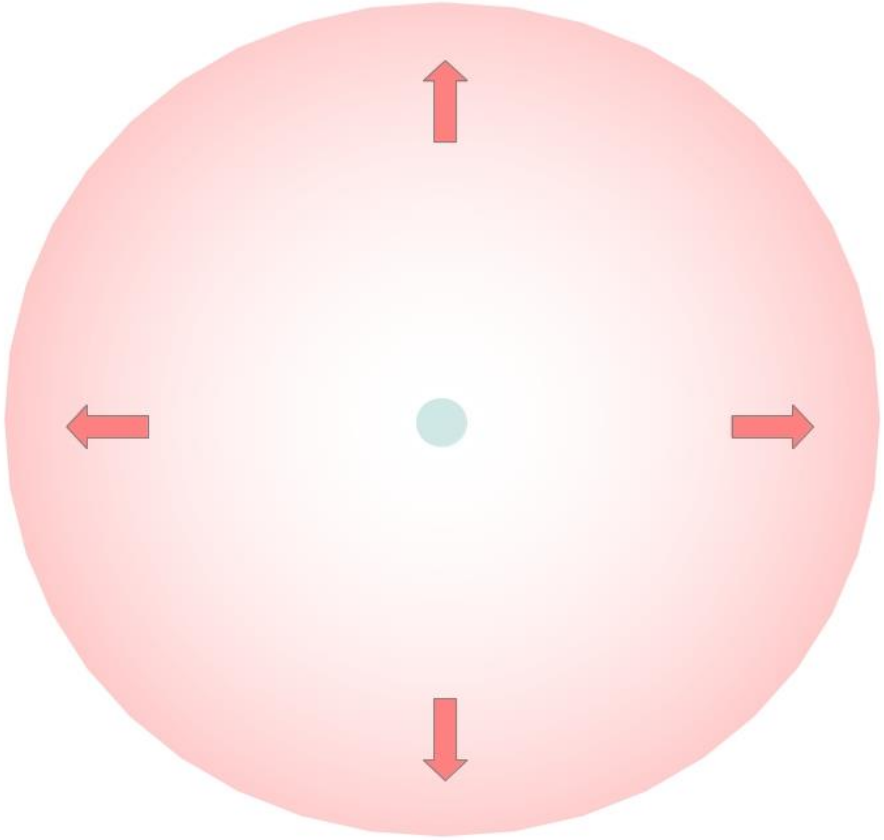
$R = 0.2\ R_O$

Formation



Red Giant

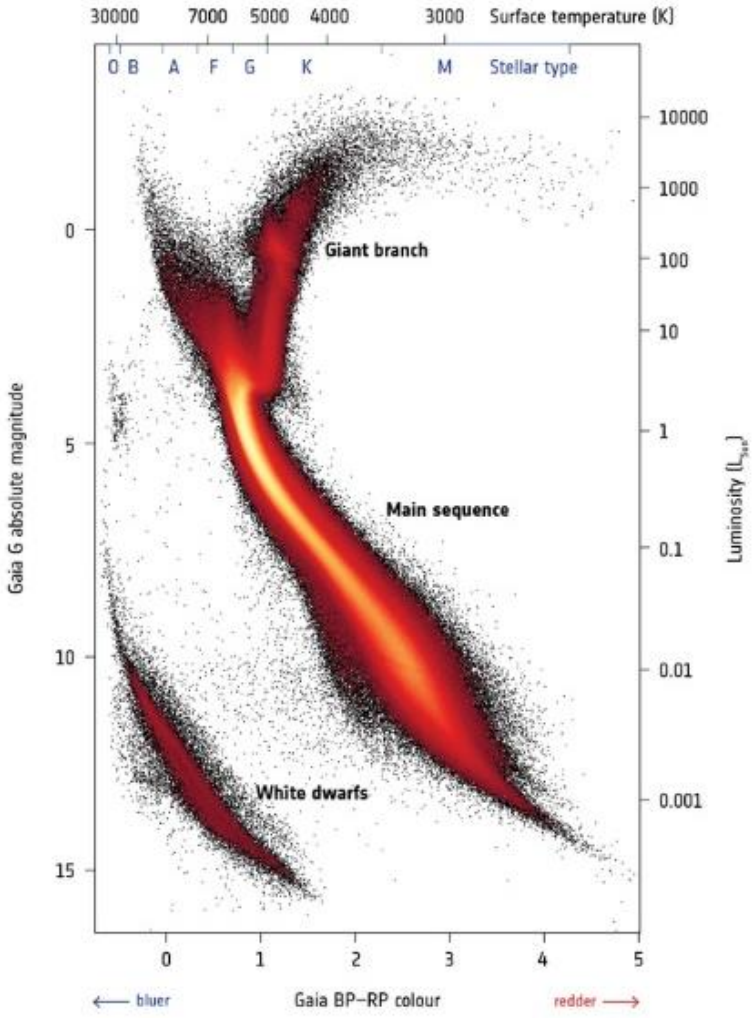
Formation



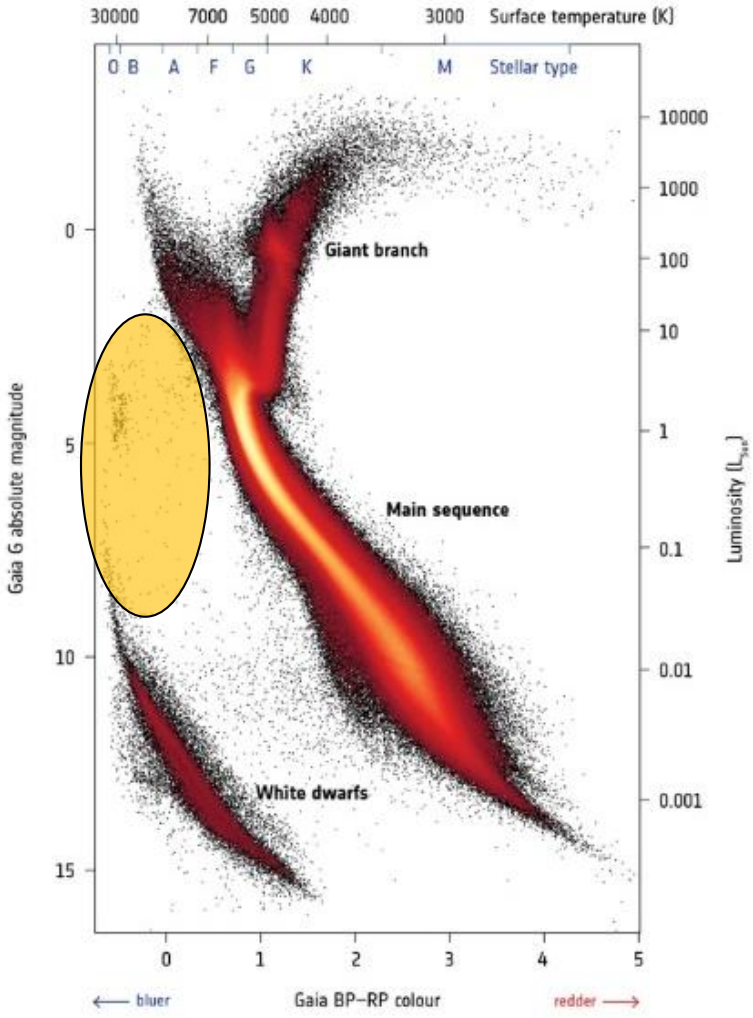
How do we find them?

fotolia / zatvorniknik (Ausschnitt)

Look for the freaks



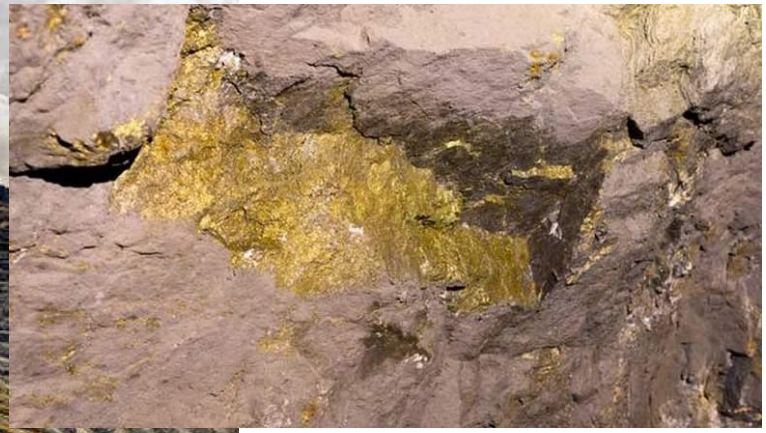
Look for the freaks



Look for the freaks

gaia

Data Mining



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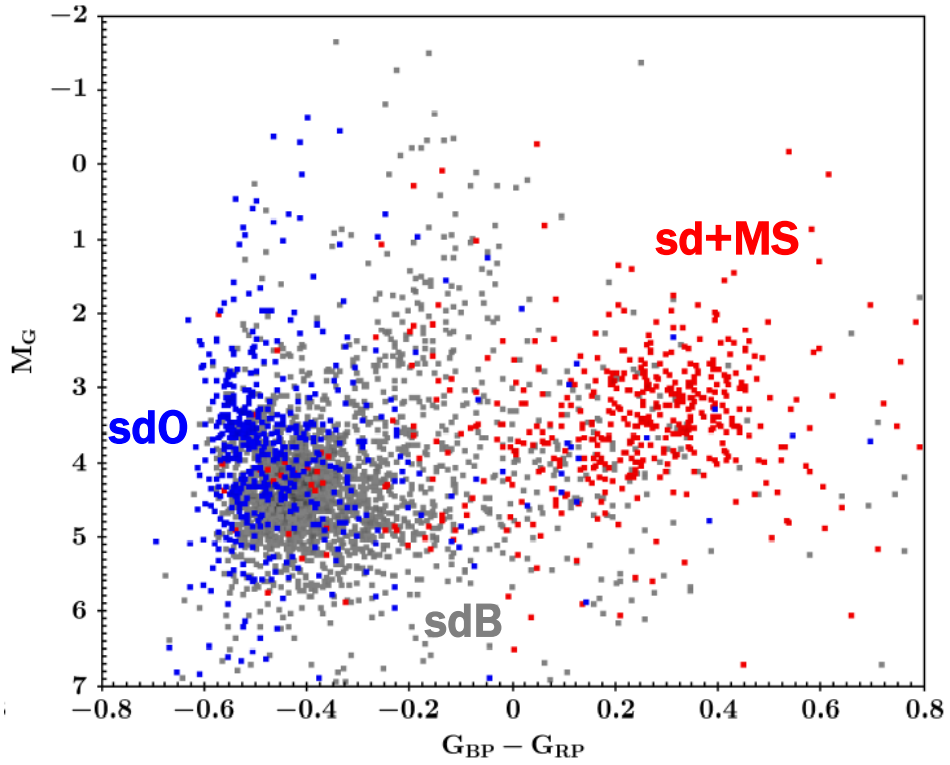
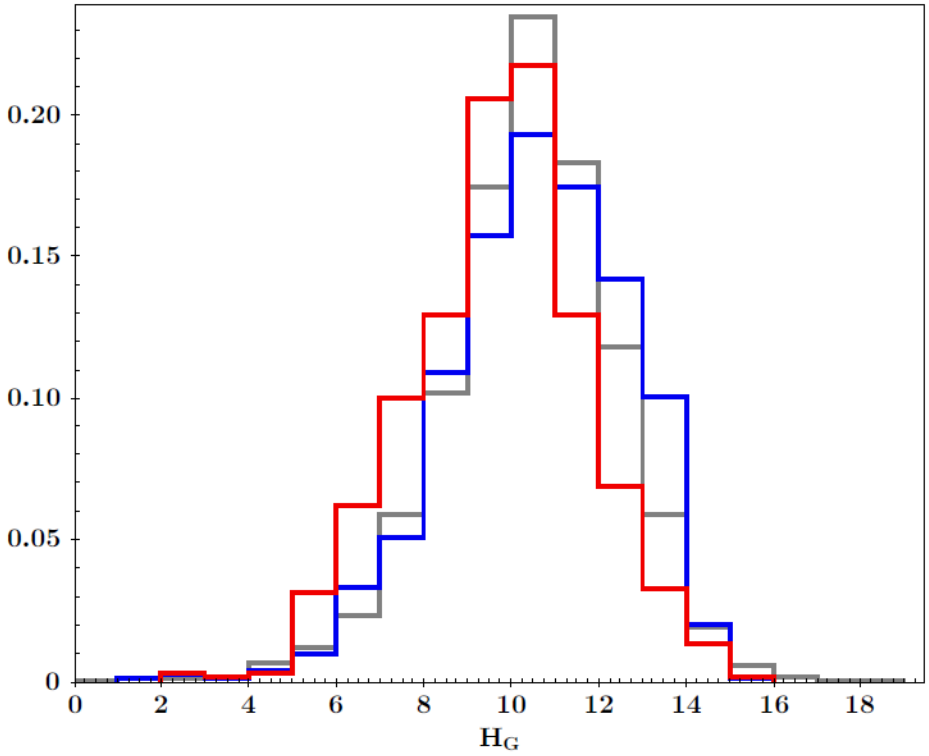
Step I: The known ones

Hot subdwarf catalog (Geier et al. 2017, A&A, 600, 50, Vizier)
5613 unique sources

- Compilation of all known larger samples of sdOBs **(inhomogeneous)**
  (sdOB database, EC, GALEX, LAMOST, FBS, SDSS DR12 ...)
- Multi-band photometry
  (GALEX, GSC, APASS, SDSS, VST, VISTA, UKIDSS, 2MASS, WISE)
- Proper motions (USNO-B1.0, SDSS, PPMXL, UCAC4, SPM4, APOP)
- Lightcurves checked for variability (SWASP, CRTS)
- 1500 sdO/Bs with atmospheric parameters and radial velocities
  (MUCHFUSS, SPY, HE, HS, GALEX, LAMOST)

Step I: The known ones

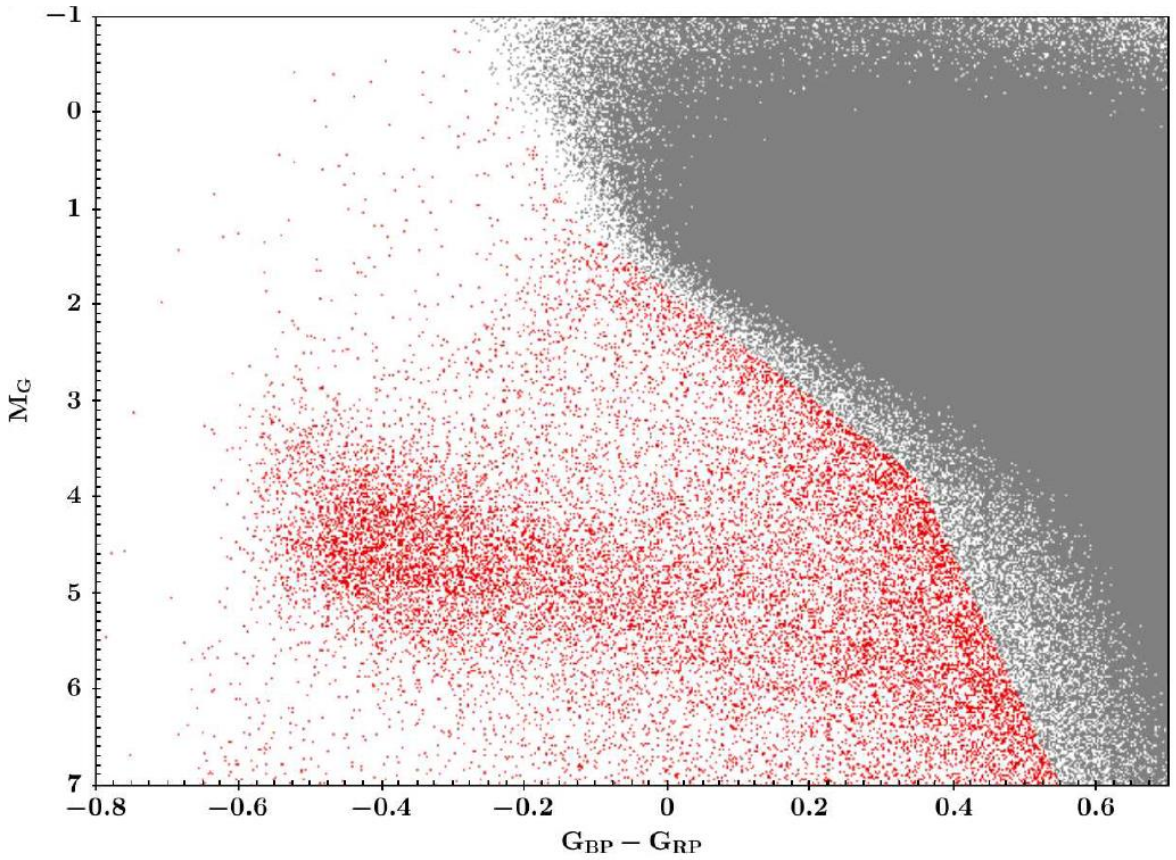




Find location in Gaia parameter space

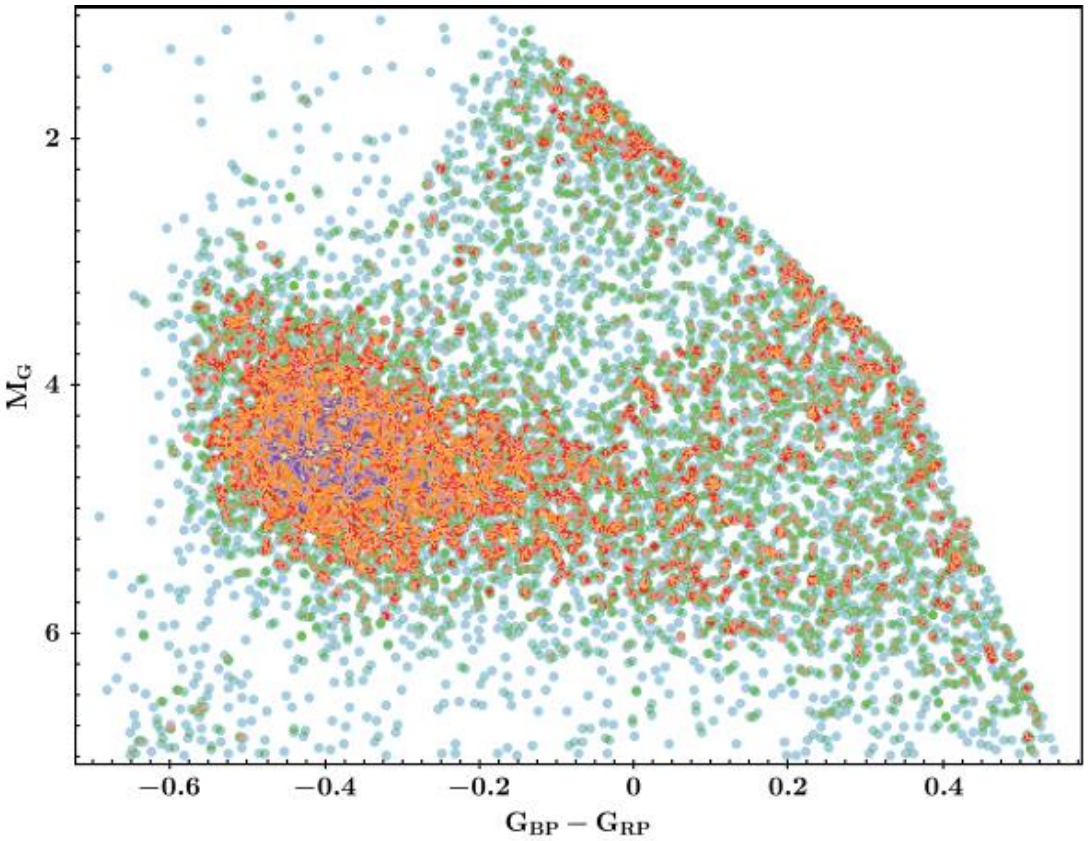
→ **Define search criteria**

Step II: Sample selection



Select all-sky sample based on those criteria

Step III: Cleaning



Astrometric

→ Gaia quality flags

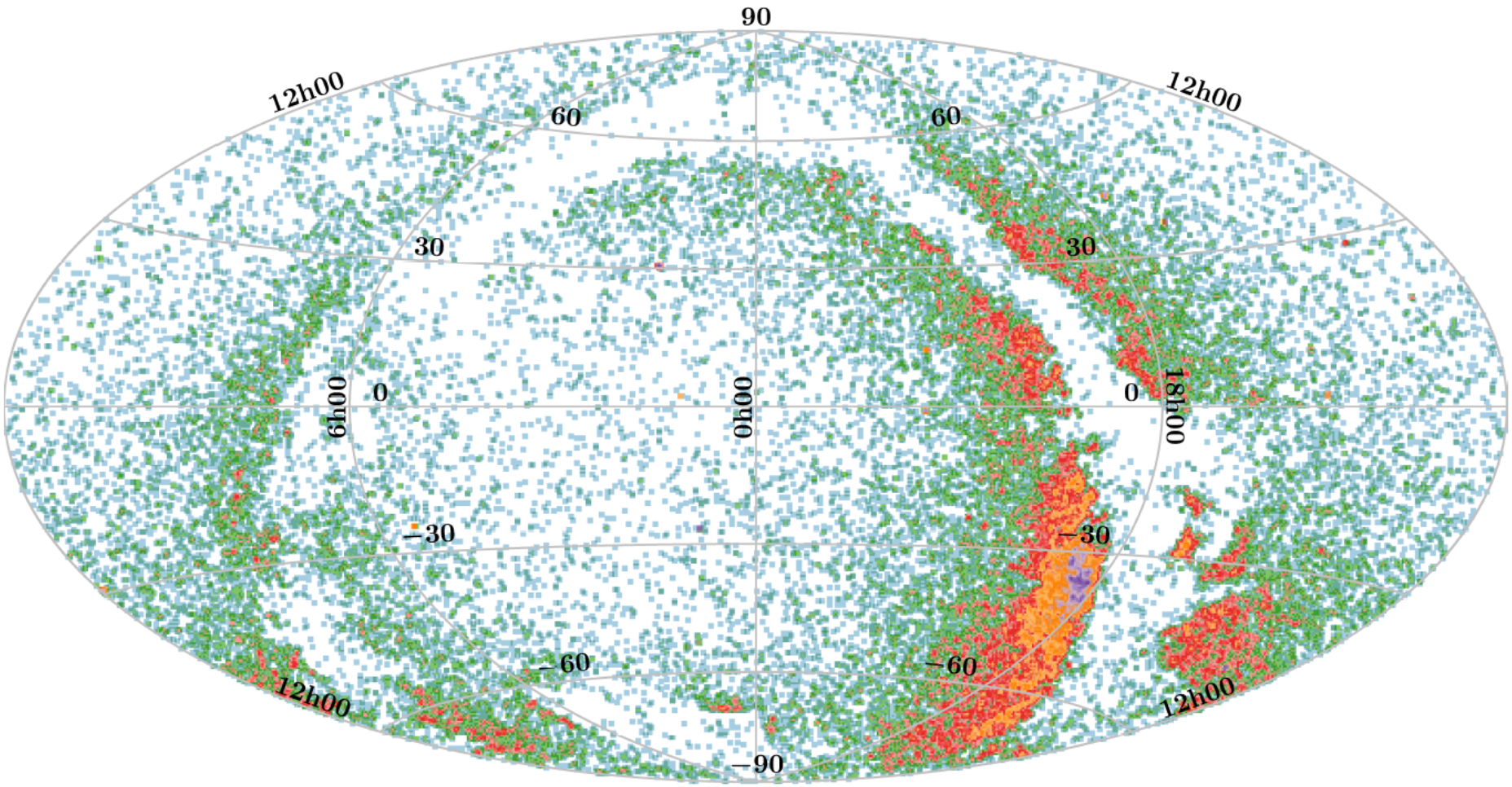
→ Stricter criteria in crowded regions

(Gentile-Fussilo et al. 2019, MNRAS, 428, 4570)

Photometric

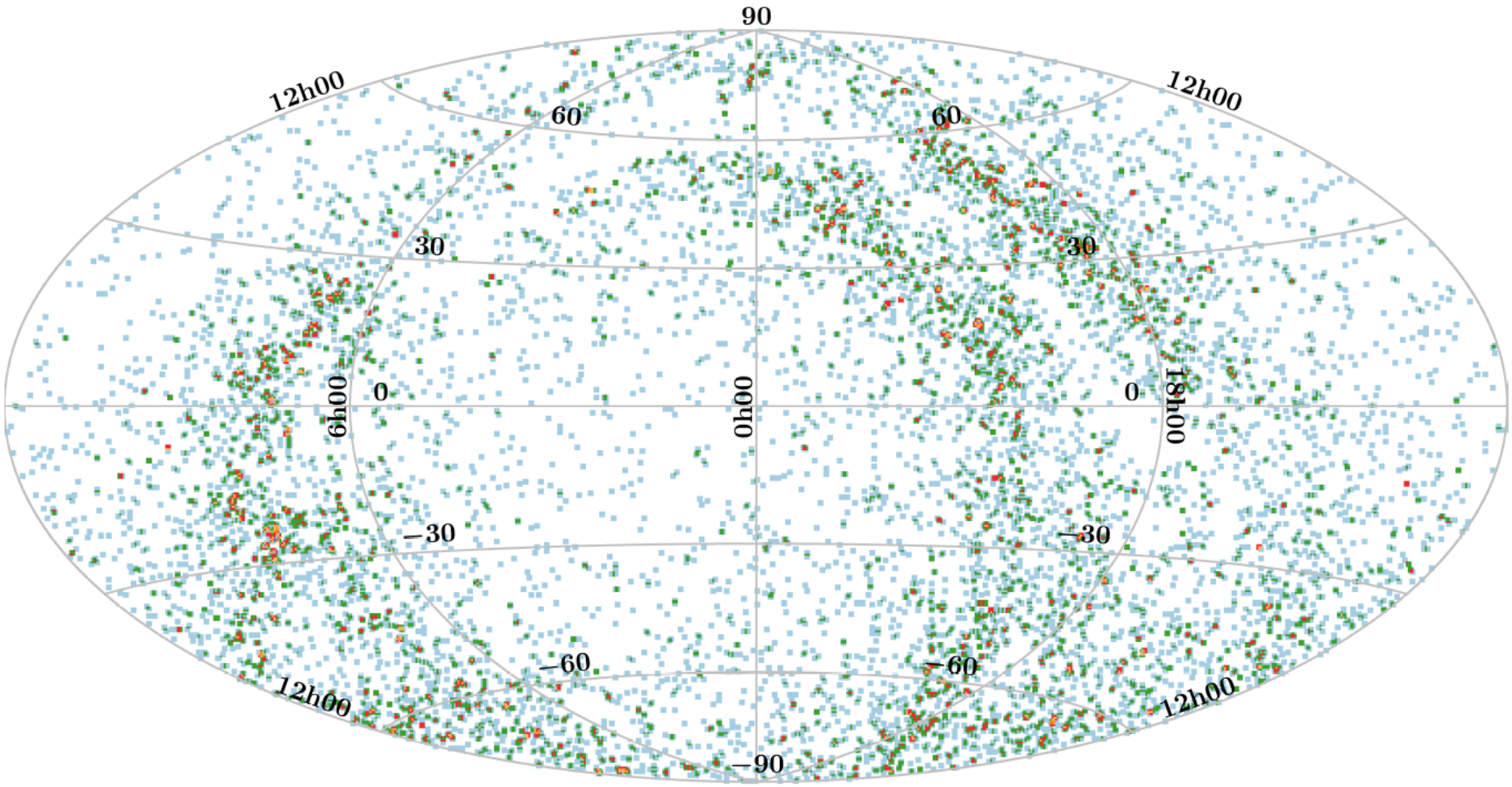
→ Additional colour selection: SDSS, PS1, SkyMapper, etc.

Step IV: Using the catalog



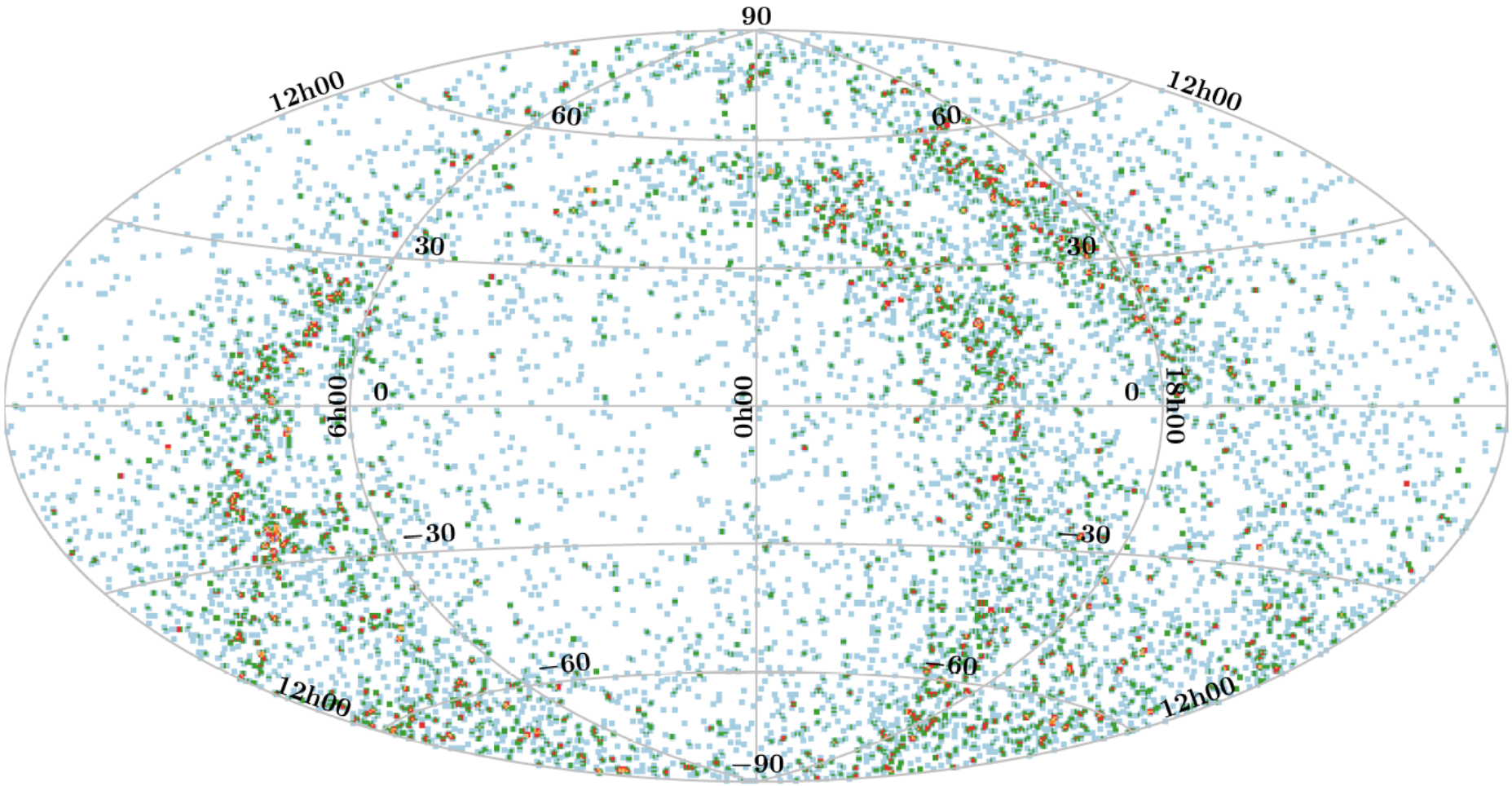
Total sample 39800

Step IV: Using the catalog



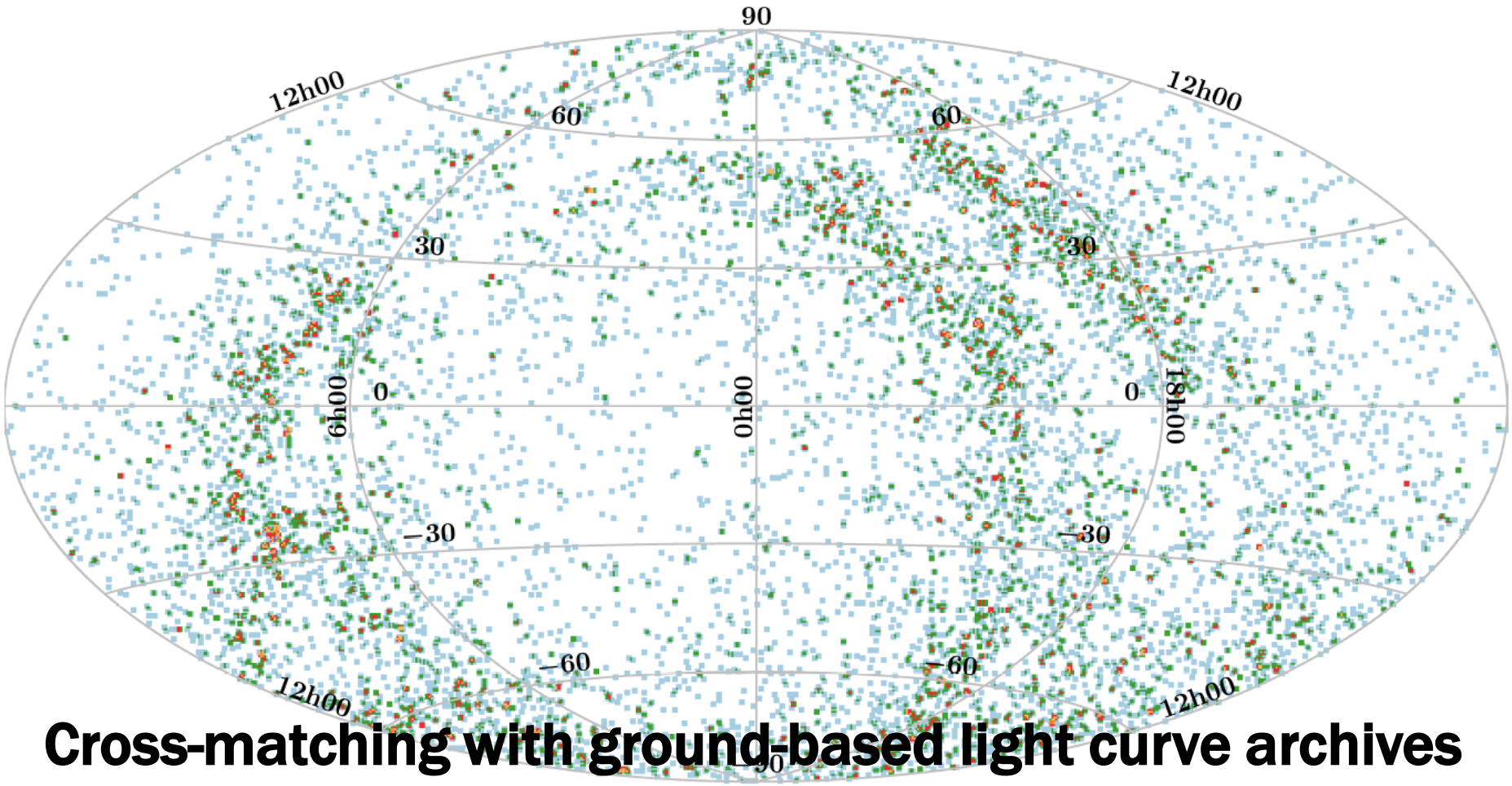
Absolute magnitude selected 8670

Step IV: Using the catalog



For details see: Geier et al. 2019, A&A, 621, 38

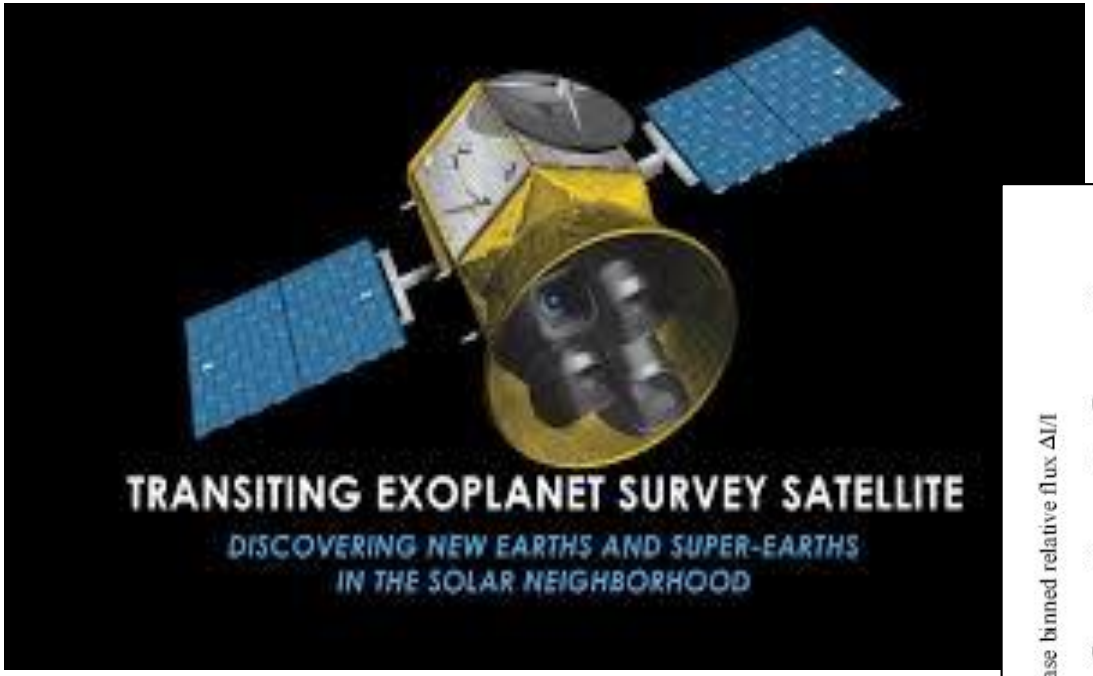
Step IV: Using the catalog

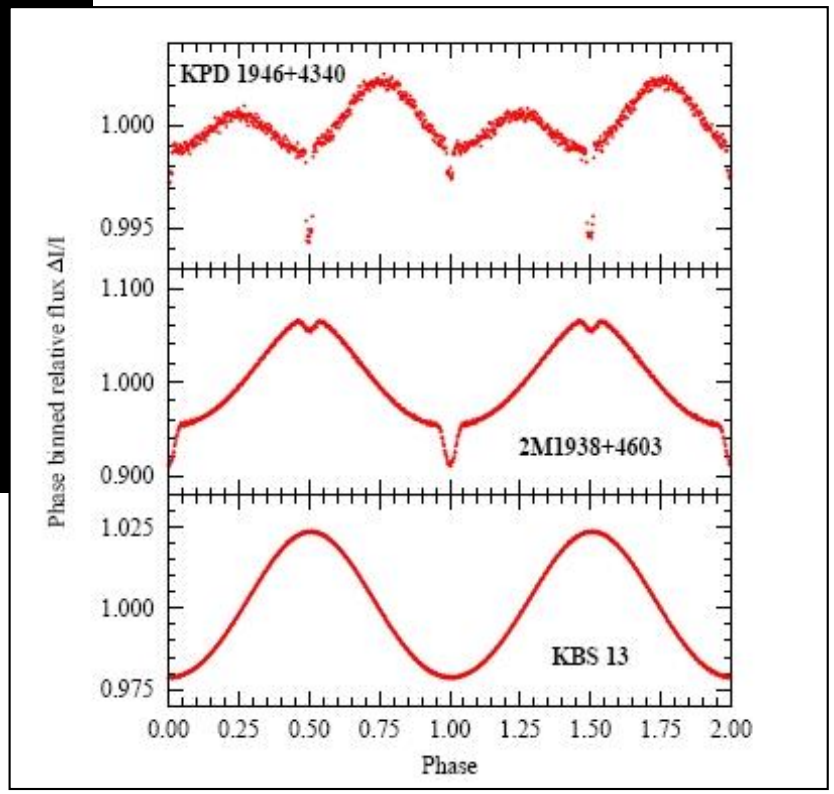


Cross-matching with ground-based light curve archives

(CRTS, PTF/ZTF, ATLAS, OGLE, ...)

Input for TESS (2018-2020)

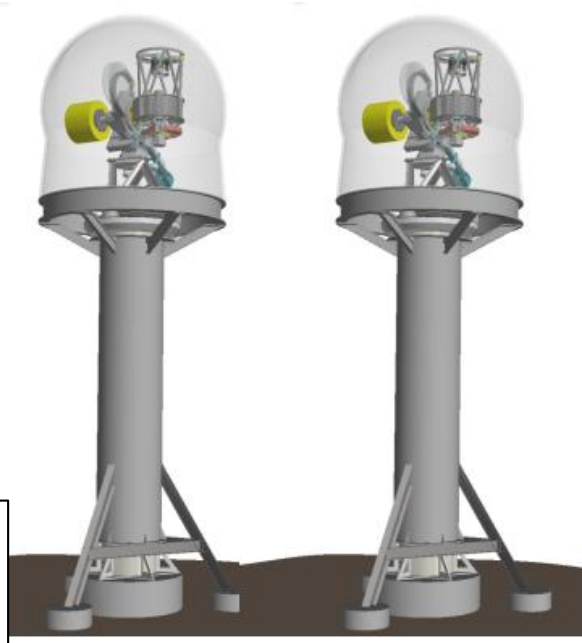


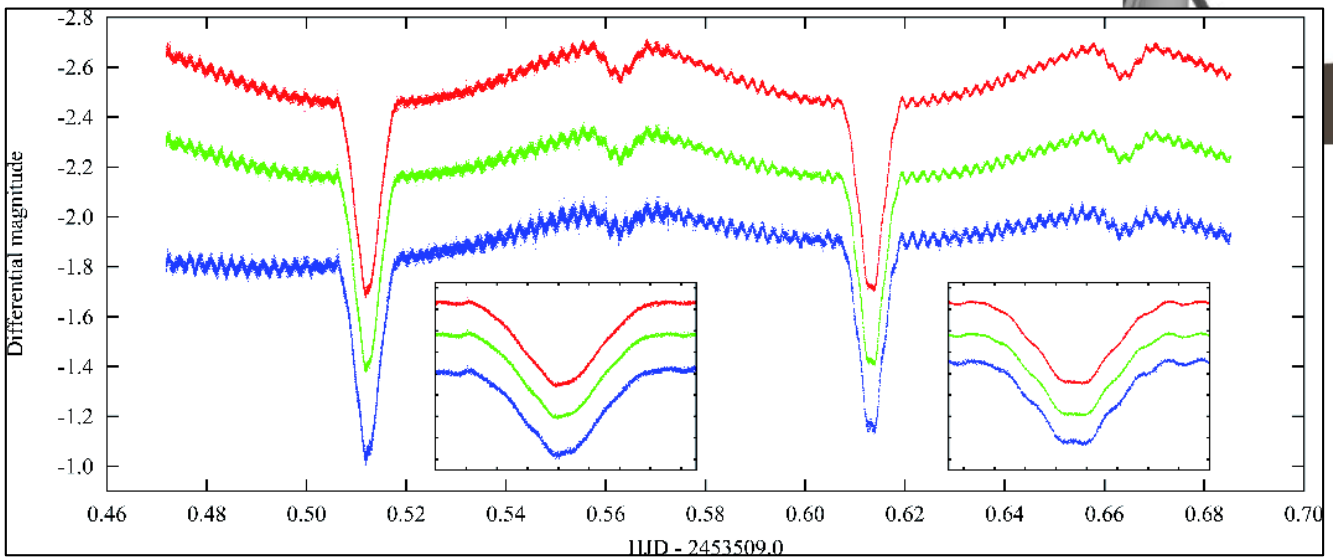


(Østensen et al. 2010)

Input for BlackGEM (2018-2023)

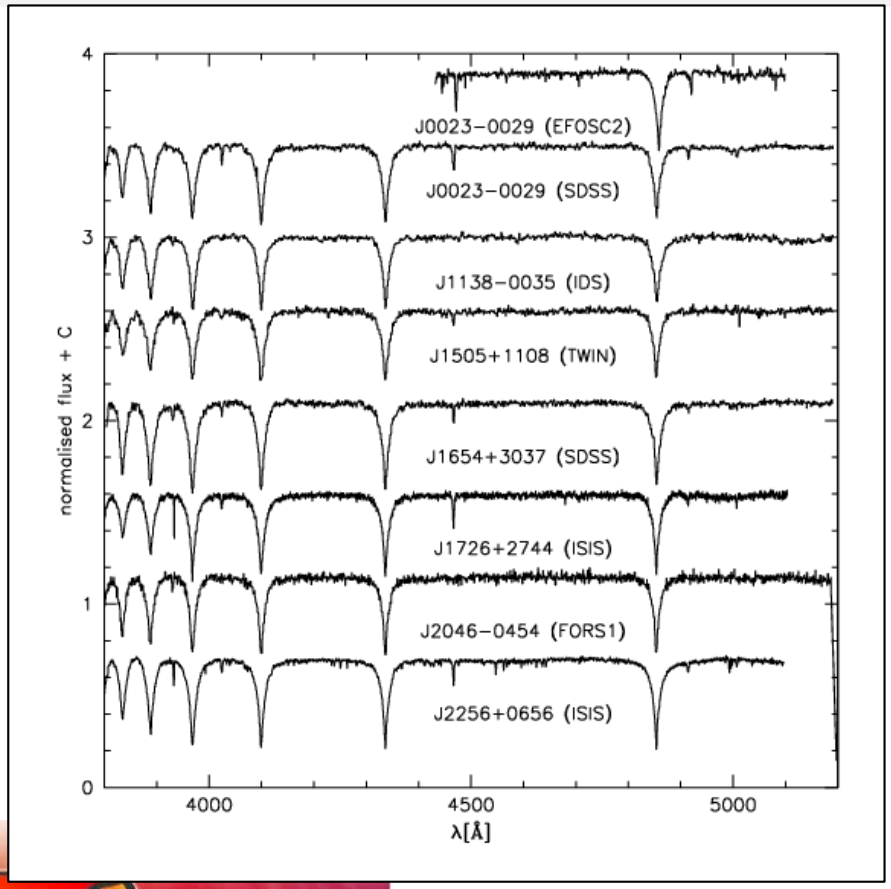
BlackGEM





(Vuckovic et al. 2007)

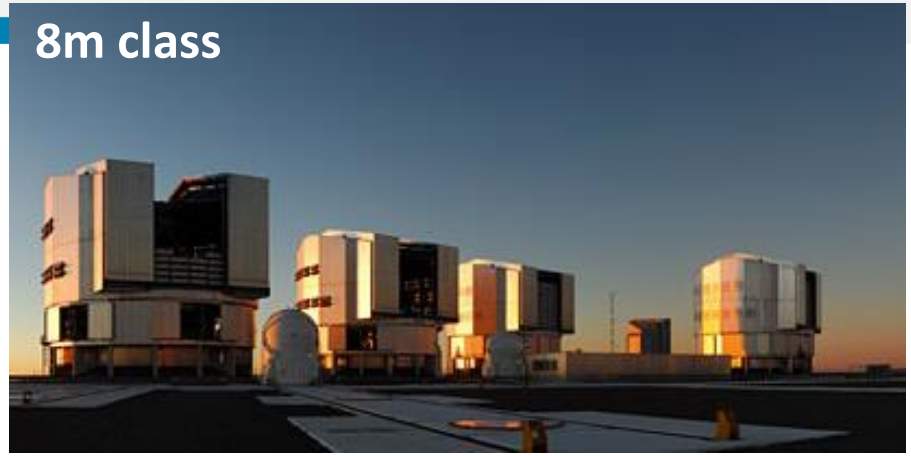
Input for 4MOST et al. (2019-2029)



Follow-up observations (optical, UV, NIR)

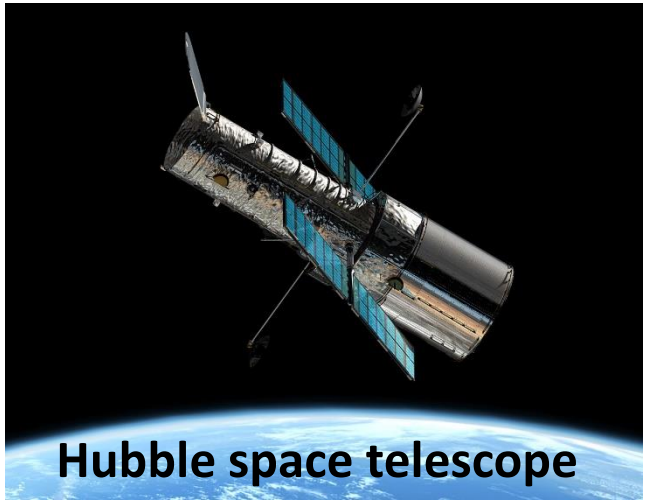
2m class

8m class



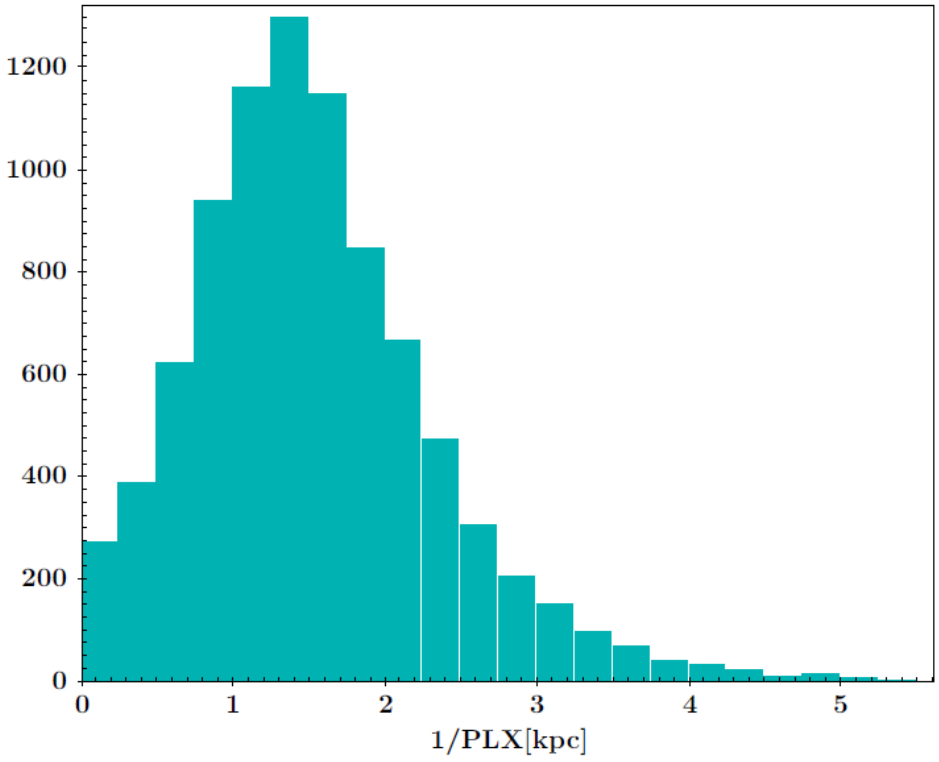
Kepler K2 mission

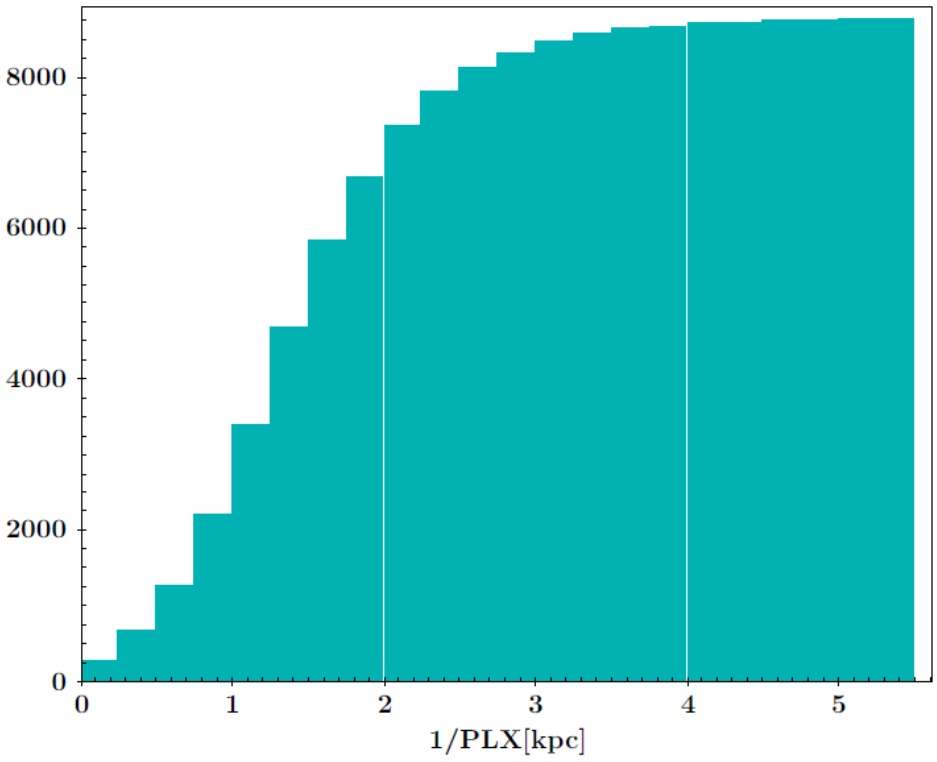
4m class



Hubble space telescope

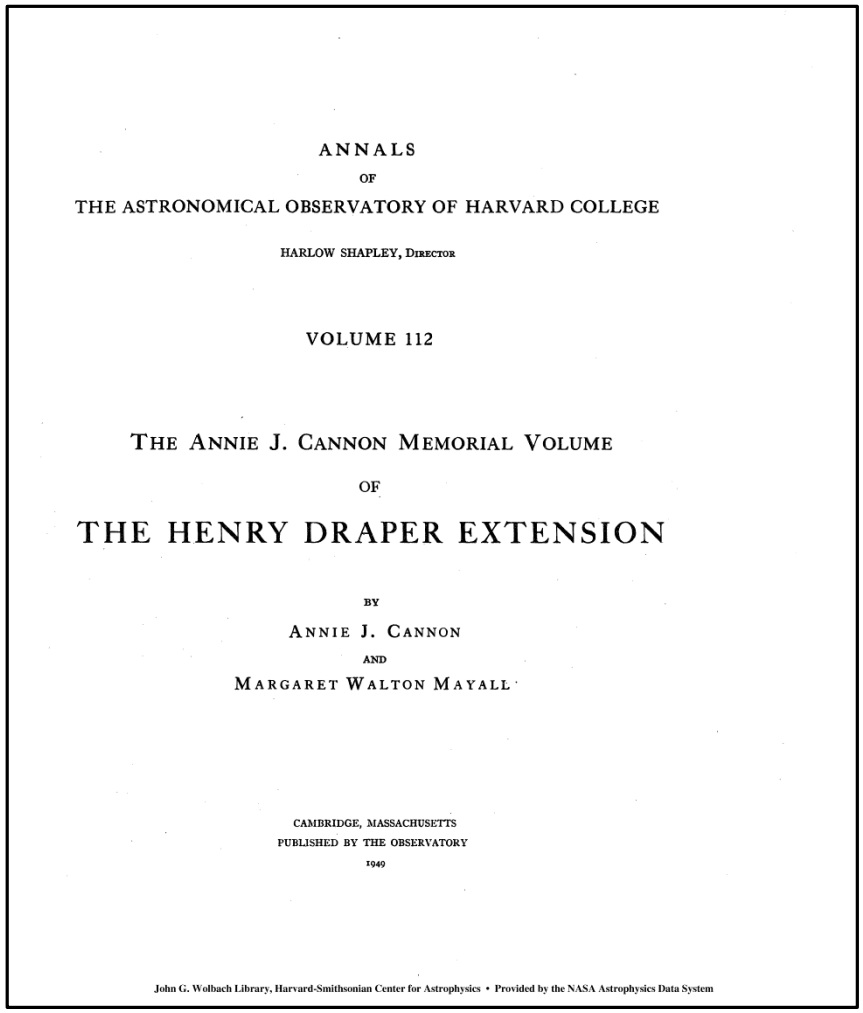
gaia Step V: Volume-limited samples





Compiling the first **volume-limited samples** of sdO/B stars

gaia Step V: Volume-limited samples



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OF
THE ASTRONOMICAL OBSERVATORY OF HARVARD COLLEGE

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VOLUME 112

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MARGARET WALTON MAYALL

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1949

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500 pc Sample:

Bright stars $G = 9 - 14$ mag

283 known hot subluminous stars (archive archaelogy)

341 candidates without classification

→ **Follow-up spectroscopy**

gaia Step VI+: Extending the catalog

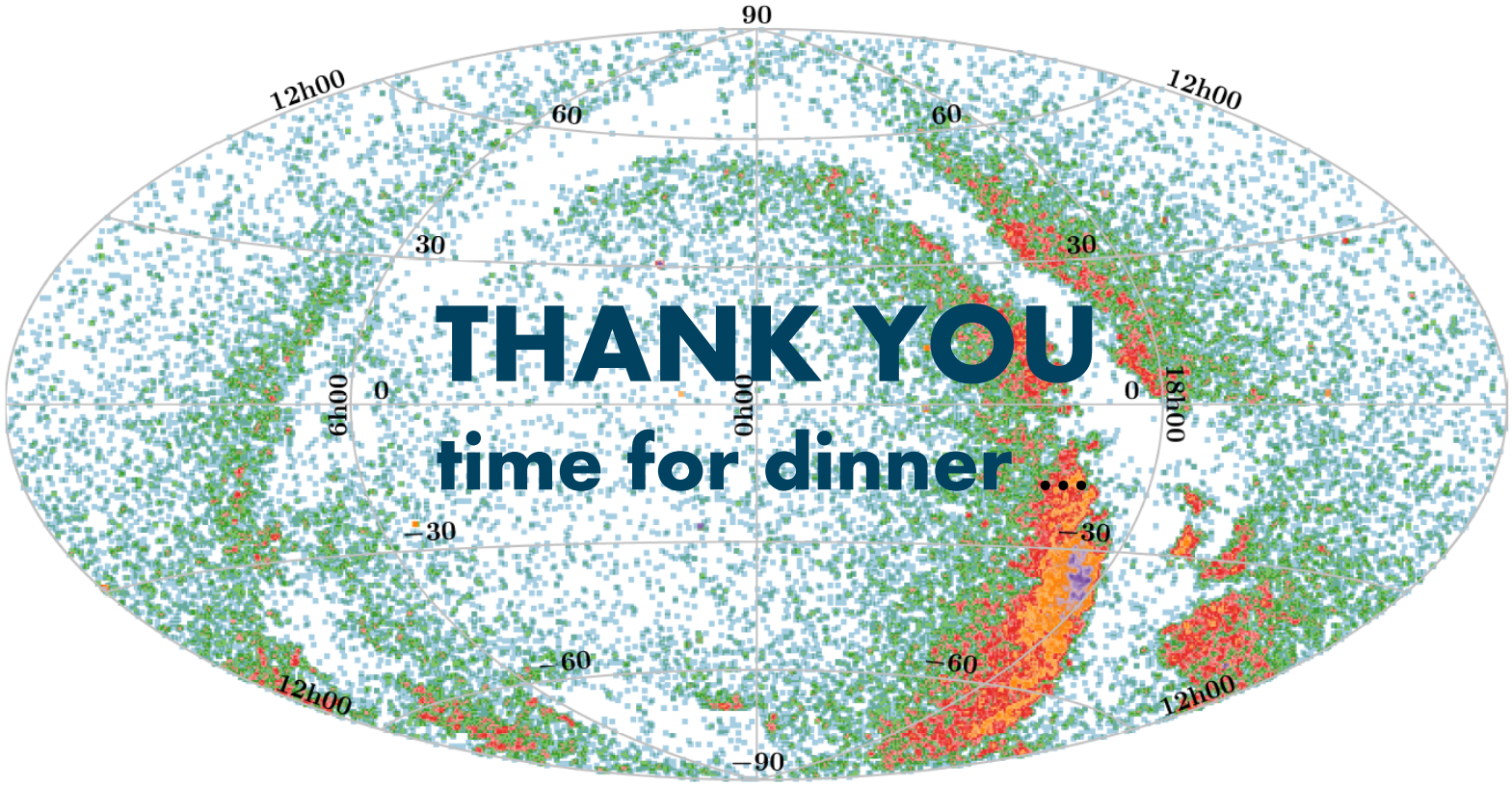
- Corrections for **reddening and extinction**
  → Removing MS-A/B stars in the disk region

- Selection beyond current magnitude limit $G = 19\,\mathrm{mag}$
  down to the Gaia magnitude limit $G = 20.7\,\mathrm{mag}$
  → More accurate Gaia astrometry in DR3+

- Cross-matching with future surveys
  (LSST, Gaia, PLATO …)

- Complete spectroscopy of the 500 pc sample and move towards the 1 kpc sample
  → Statistically significant numbers of halo stars

gaia Step VI+: Extending the catalog



J. Vos, I. Pelisoli, V. Schaffenroth, N. Reindl (Potsdam), R. Raddi, U. Heber, D. Schneider (Bamberg), N. Gentile-Fusillo, T. R. Marsh (Warwick)