Input Star Catalogs

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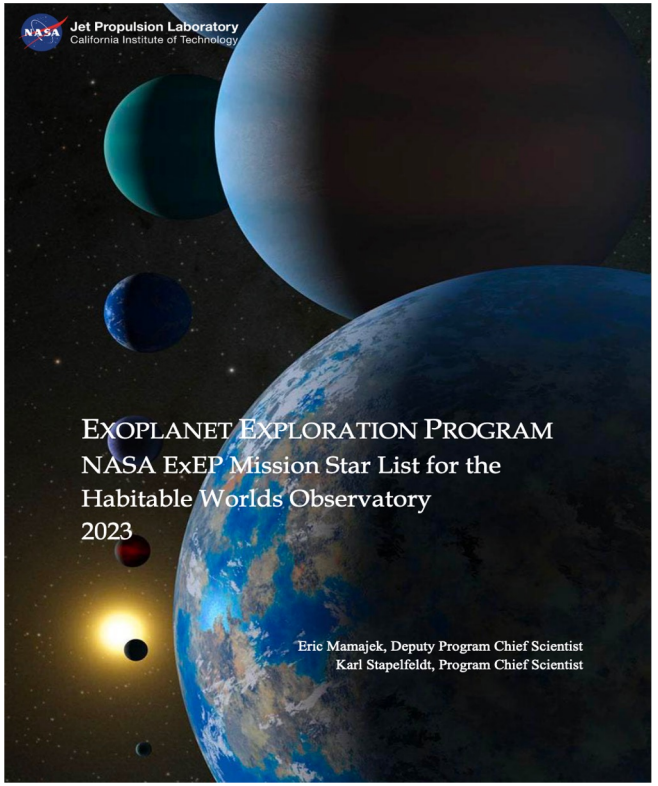
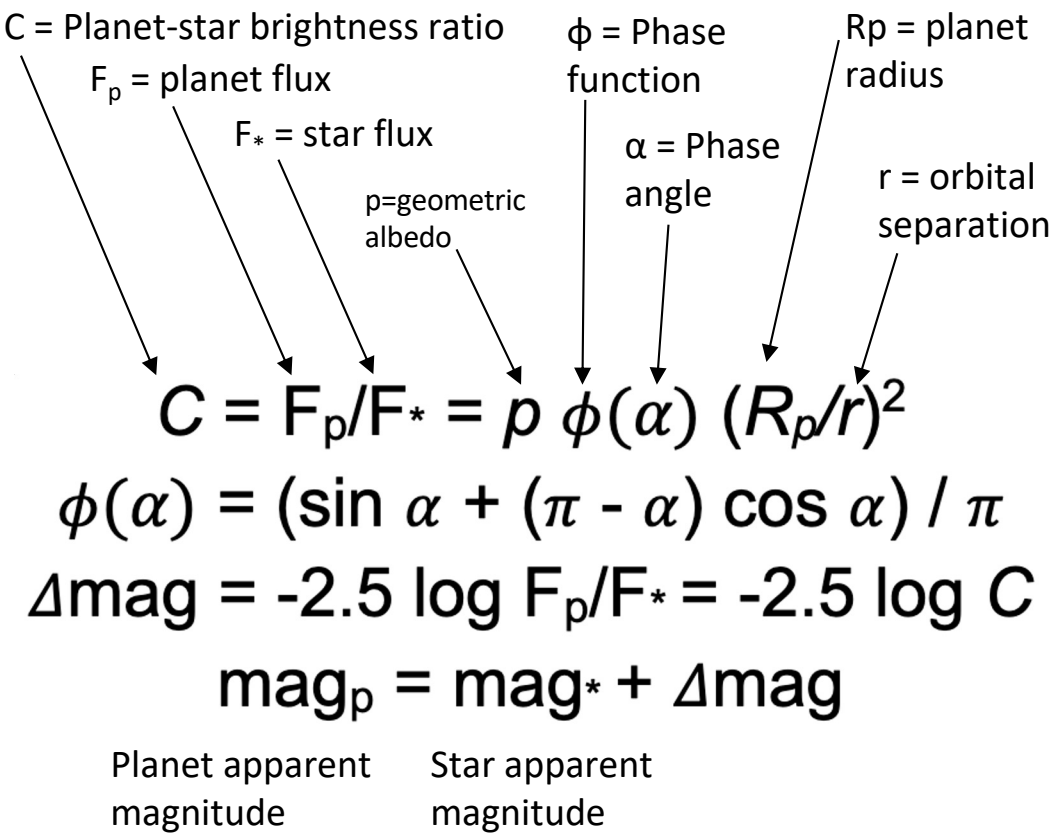
Exoplanet Yield Modeling Workshop
242nd AAS Meeting, Albuquerque
June 8, 2023



Government sponsorship acknowledged
CL#23-2660

What stellar parameters do yield modelers care about?



(see review by Traub & Oppenheimer 2010 in *Exoplanets*)

Key questions:

- How *bright* will hypothetical exoplanet be?
- What is the *planet-star brightness* ratio?
- At what *angular separation* is the exoplanet from the star?

Key stellar parameters:

- *Brightness* of star in some band
- *Luminosity* of star (to predict habitable zone and/or Earth-equivalent Instellation Distance (EEID))
- *Distance* to star & exoplanet

Input Catalogs and Resources

Large star catalogs	Hipparcos Gaia DR3 TIC, WDS, SB9
Online access to star catalogs & electronic tables	SIMBAD, Vizier MAST NASA Exoplanet Archive
Star catalogs compiled for exoplanet yield calculations	ExoCAT (2015) ExEP HWO Star List (2023) Tuchow & Stark (in prep.)

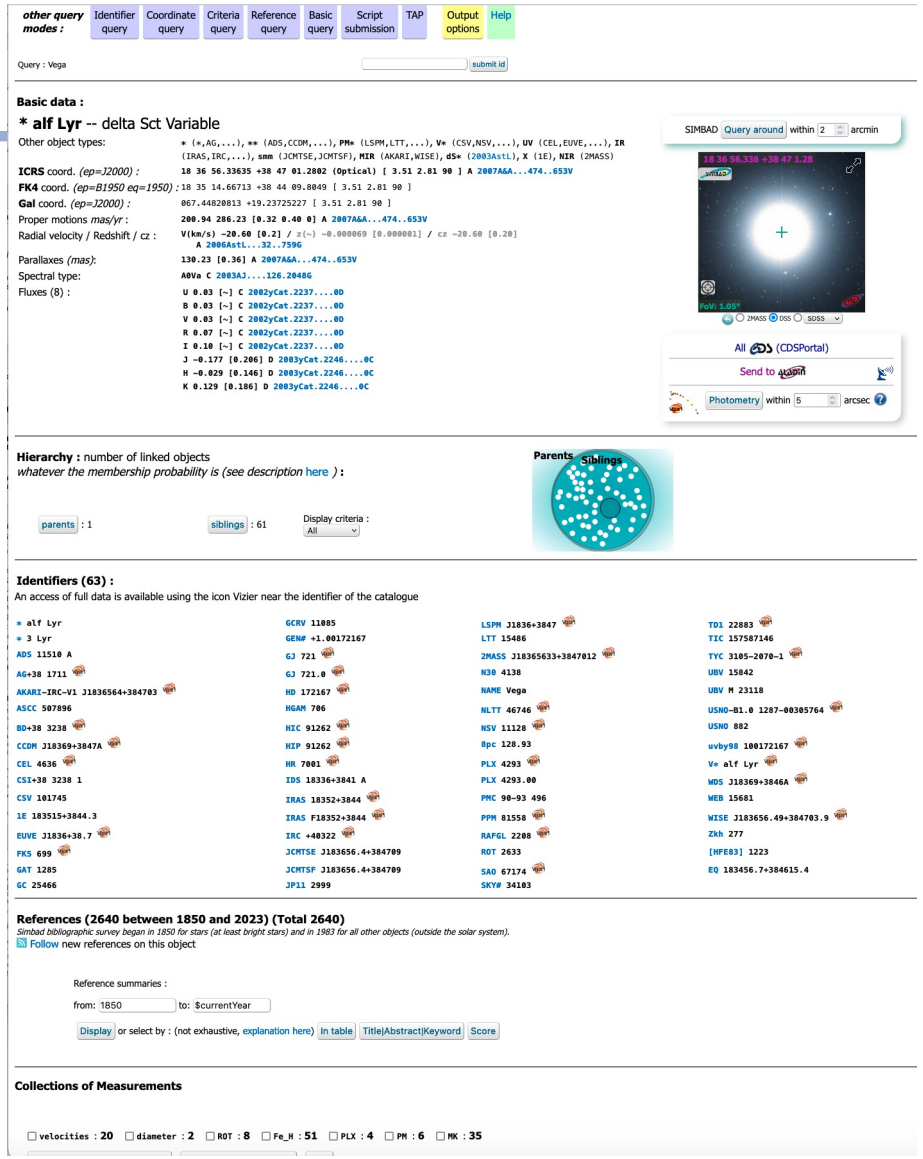
Raw Sources of Stellar Data: Input Star Catalogs

- Getting familiar with star catalogs: SIMBAD and Vizier
  - **SIMBAD** astronomical database provides basic data, cross-IDs, bibliography and measurements for astronomical objects outside the solar system: http://simbad.cds.unistra.fr/simbad/
  - **Vizier** allows you to query electronic tables (e.g., star catalogs, tables from journal articles) by celestial position or a SIMBAD-resolvable designation (e.g., “HD 172167”, “HR 7001”, “GJ 721”, “Vega”, “alf Lyr”): https://vizier.cds.unistra.fr/viz-bin/VizieR
- Generally, the brighter the star, the better studied it is, and the more catalogs and electronic tables it appears in.
- ALL star catalogs have limitations and issues to be aware of
- **NO single star catalog has it all**

SIMBAD entry for a star

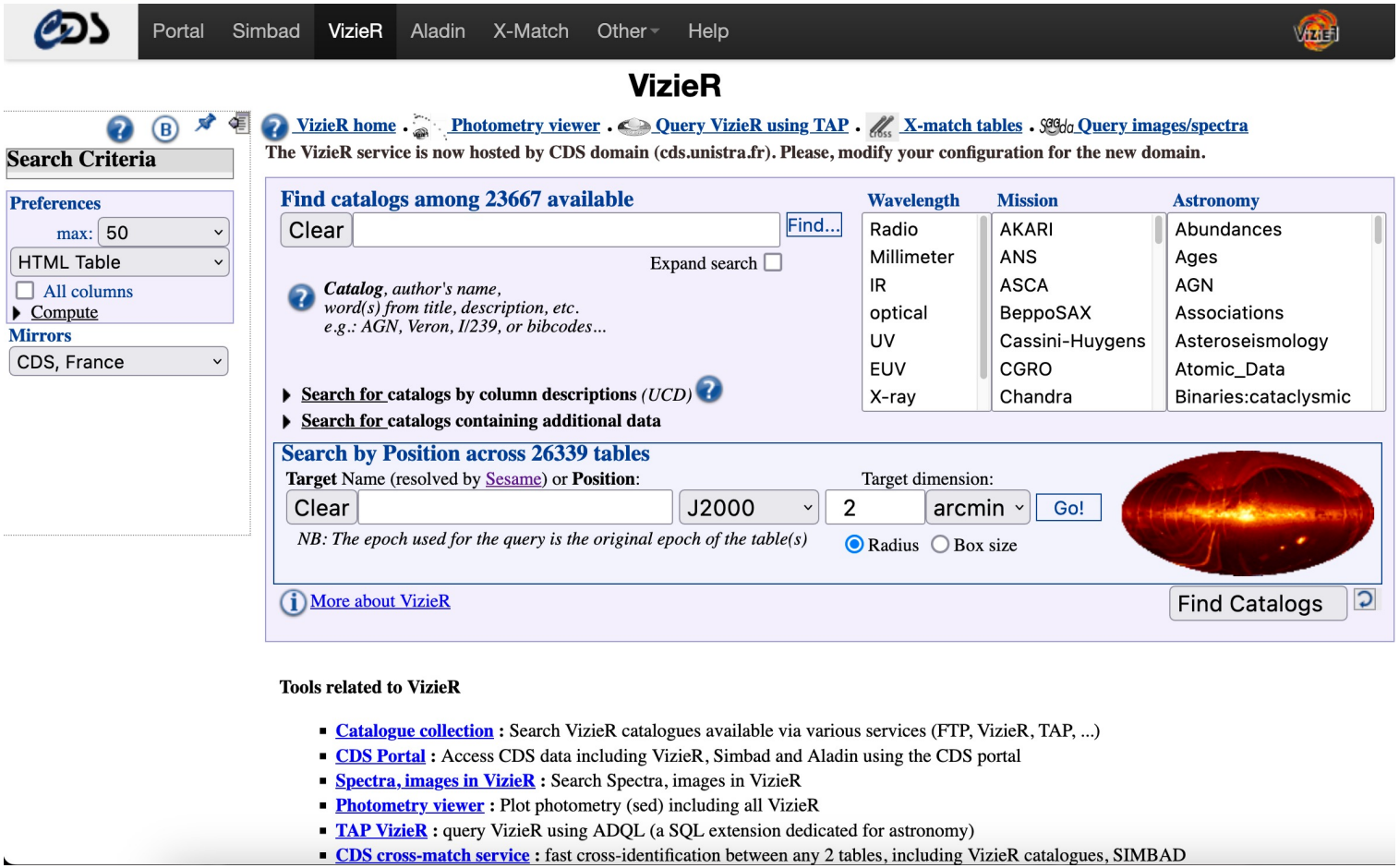
(in this case for a very bright, famous star)

http://simbad.cds.unistra.fr/simbad/sim-id?Ident=Vega



Vizier

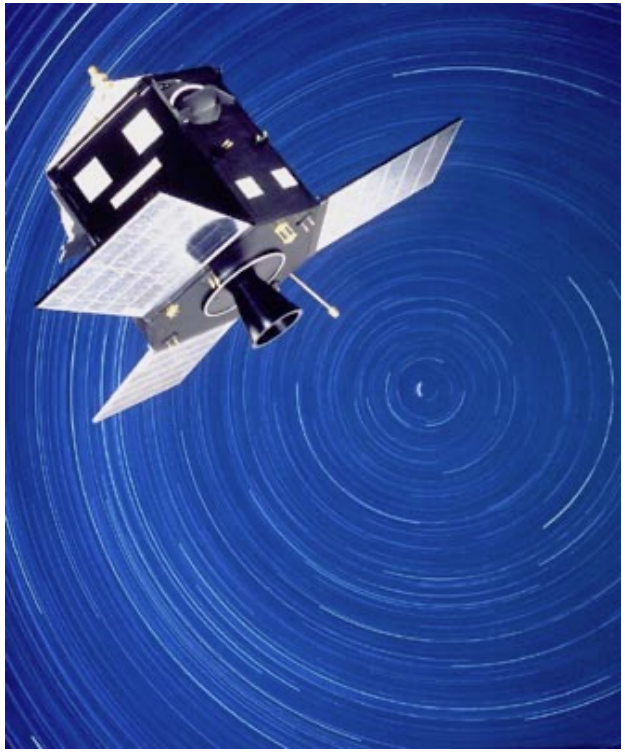
Query electronic tables around a position or SIMBAD-resolvable name



https://vizier.cds.unistra.fr/viz-bin/VizieR

Hipparcos & Tycho

- ***Hipparcos*** was an ESA space astrometry mission; observed stars all over sky between 1989-1993.
- ***Hipparcos (HIP)*** catalog of positions, proper motions, parallaxes, photometry (measured Tycho B_T,V_T system => BV Johnson), astrometry for 118,218 *pre-selected* stars published 1997. Parallaxes ~1 mas accuracy (Perryman+1997, ESA 1997).
- ***Tycho (TYC)*** catalog of ~million stars (1997), reanalyzed and connected to recalibrated century-old positions => improved proper motions (TYC-2, 2000)
- "**HIP2**" reanalysis by van Leeuwen (2007)
- Completeness *varies over sky*: V ~ 7.3-9.0 mag
- Formed basis for numerous surveys the past ~25 yrs



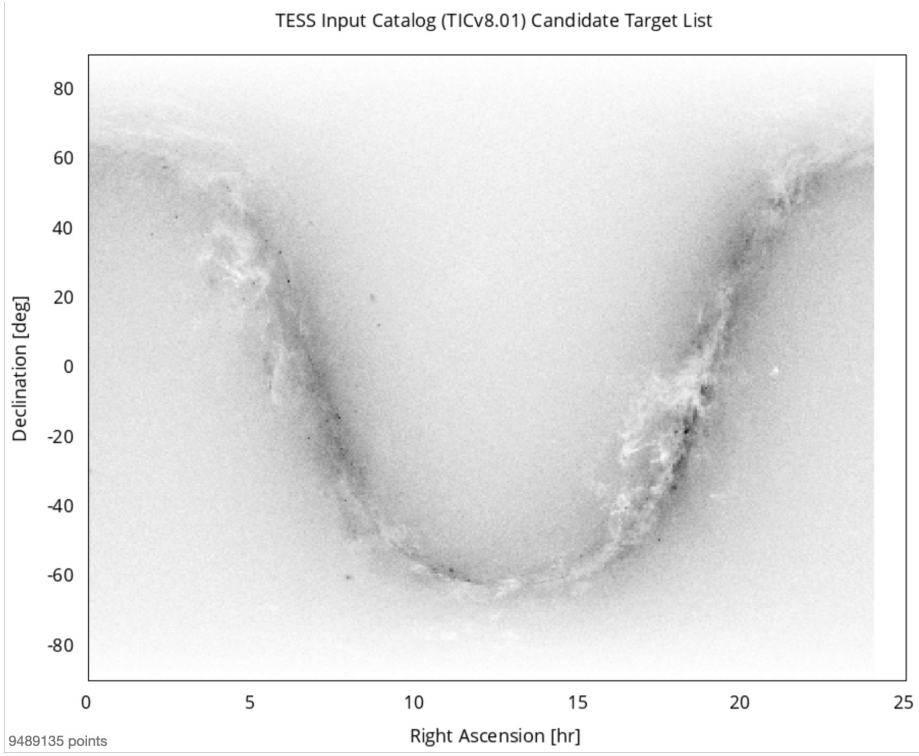
(ESA, https://www.cosmos.esa.int/web/hipparcos)

Gaia

- ESA ***Gaia*** mission launched December 2013
- Measured positions, proper motions, parallaxes, photometry for nearly 2 billion objects (including spectra, radial velocities, variability analysis for millions of objects) – creating largest, most precise 3D map of the Milky Way!
- Multiple data releases: DR1(2016), DR2(2018), DR3(2022)
- Contents of Gaia DR3: https://www.cosmos.esa.int/web/gaia/dr3
- Volume-limited catalogs:
  - **The Fifth Catalogue of Nearby Stars (CNS5)** – 5931 objects within 25 pc (Golovin+2023, https://dc.g-vo.org/CNS5) – update to "Gliese-Jahreiss (GJ) catalog"
  - **The Gaia Catalogue of Nearby Stars** – 331,312 objects within 100 pc (Gaia Collaboration, Smart+2021, http://cdsarc.u-strasbg.fr/viz-bin/cat/J/A+A/649/A6)

TIC: TESS Input Catalog

- Compiled catalog of stellar parameters for 1.5 billion sources
- TIC v7 based on 2MASS, TIC v8 based on Gaia DR2
- Matched to 2MASS, UCAC4, APASS, SDSS, WISE. Estimated stellar parameters!
- Includes magnitudes in B,V,G,u, g,r,I,z,J,H,Ks,W1,W2,W3,W4
- https://tess.mit.edu/science/tess-input-catalogue/
- Stassun, Oelkers, Paegert+ 2019 (v8.0)
- Binaries & artefacts are an issue for 1% of sources (see Paegert+ 2021 v8.2 update arXiv:2108.04778)

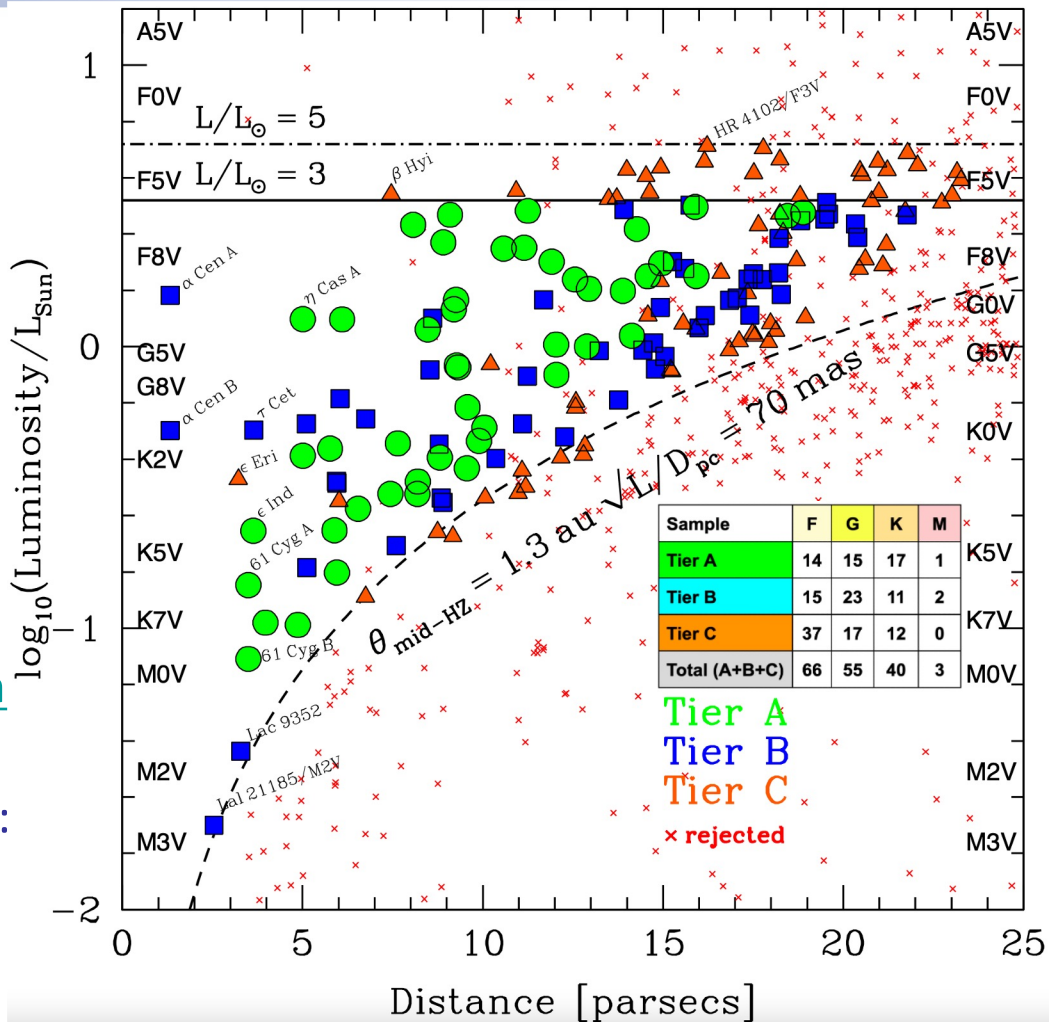


Binaries

- **Stellar multiples** are the bane of all star cataloguing efforts (and a source of bane for starlight suppression techniques to image exoplanets!)
- **Washington Double Star (WDS)** Catalog (Mason+2001)
  - Contains resolved companions (imaging, speckle, AO, occultation)
  - Contains mix of physical companions and 'interlopers'
  - Regularly updated: http://www.astro.gsu.edu/wds/
- **9th Catalogue of Spectroscopic Binary Orbits (SB9)** (Pourbaix+2004)
  - Was regularly updated through 2011 https://sb9.astro.ulb.ac.be/
- **Gaia** catalogs include some new companions, even for relatively nearby, bright stars at tens of pc! (see Kervella+2022)

ExEP Mission Stars List for HWO (2023)

- NASA ExEP scientists Eric Mamajek & Karl Stapelfeldt presented an initial HWO target star list in January 2023 to motivate precursor science activities on stars most amenable to imaging exoEarths w/ a 6-m space telescope
- 164 stars in 3 tiers. Tiers factored in planet-star ratios of exoEarths, binarity, disks. ~50 data columns.
- Documentation & Seminar Slides: https://exoplanets.nasa.gov/exep/science-overview/
- Online table at NASA Exoplanet Archive: https://exoplanetarchive.ipac.caltech.edu/cgi-bin/TblView/nph-tblView?app=ExoTbls&config=DI_STARS_EXEP



Acknowledgements

Thanks to the NASA Exoplanet Exploration Program for support.

This work was carried out at the Jet Propulsion Laboratory, California Institute of Technology under contract with the National Aeronautics and Space Administration.