### The Gaia DR3 Exoplanet Opportunity

#### Johannes Sahlmann

RHEA Group for ESA, European Space Astronomy Centre

MAESM, 2022-10-04

# DR3 treats binary stars as such for the first time and includes exoplanet (re-)discoveries

#### **Photometry:**

first Gaia discoveries of transiting Gaia-1b & Gaia-2b (Panahi et al. 2022), several re-discoveries, and many candidates

#### **Radial velocity:**

DR3 contains many candidates with some re-discoveries (e.g. WASP-18b)

#### Astrometry:

- Gaia astrometry unrivalled by other instruments -> a unique windows for discovery
- Astrometric orbits of known exoplanets, e.g. HD 81040 b
- Tens of new exoplanet candidates
- Confirmation usually necessitates additional analyses and/or data that are not part of DR3

#### List maintained at https://www.cosmos.esa.int/web/gaia/exoplanets



Gaia

Credits: ESA/Gaia/DPAC, Gaia Collaboration, Arenou et al. 2022



## DR3 contains the first uniform and large-scale census of astrometric binaries



~169 000 astrometric orbit solutions, most correspond to unresolved "astrometric binaries".

DR3 contains 300 times as many "astrometric binaries" compared to the Washington Double Star Catalogue.





### Gaia re-discovered the planet orbiting HD81040

https://www.cosmos.esa.int/web/gaia/iow\_20220131





#### Gaia discovers new exoplanet candidates

Super-Jupiters around the main-sequence stars HIP 66074 and HIP 28193



Substellar companions to the young stars HD 3221 and 2MASS J02192210-3925225 A super-Jupiter orbiting the nearby metal-polluted white dwarf WD 0141-675



Credits: ESA/Gaia/DPAC, Gaia Collaboration, Arenou et al. 2022; Holl et al. 2022



#### Gaia starts harvesting exoplanet orbits





#### Gaia starts harvesting exoplanet orbits





## Opportunity 1: Orbital solutions of known exoplanets (and BD-companions and binary stars)

DR3 orbital solutions (deliberately) were derived from Gaia data only. Combined solutions, e.g. Gaia astrometry + external radial velocities, were not released.

DR3 does not include epoch astrometry, hence combined solution have to consider the DR3 solution parameters and their covariances, e.g. through a "Gaia likelihood function" (Winn 2022).

Winn (2022) validated several DR3 exoplanet solutions and raised awareness for pitfalls that may remain, e.g. additional companions (HD111232) and inconsistent solutions (HIP66074).





## Opportunity 2: Mapping the transition region between giant planets and brown-dwarf companions





## Opportunity 2: Mapping the transition region between giant planets and brown-dwarf companions

- Weed out the obvious falsepositives (here: binary stars)
- Crossmatch with existing catalogs and observations
- Follow-up for confirmation (spectroscopy, radial velocity, ...)





### **Opportunity 3: DR3 acceleration solutions**

Acceleration solutions can indicate the presence of a longer-period companion (DR3 timespan is ~ 1000 days).

DR3 solutions are not easily interpreted (Gaia Collaboration, Arenou et al. 2022; LL-136)

Yet, clear correlations with the HIP-Gaia accelerations have been demonstrated.

Careful analyses may lead to exciting discoveries.







Gaia DR3 non-single star solutions touch upon exoplanet and brown-dwarf research in several areas. They are yet under-explored.

Gaia consortium and partners provide lots of detailed documentation, examples, training material, etc. Reach out in case of questions.

Working with DR3 is optimal preparation for what will come in DR4.

Please have a look at Gaia Collaboration, Arenou et al. 2022 (2022arXiv220605595G)

