Encyclopedia of Exoplanetary Systems

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Paris Observatory/LESIA

Journées ASOV 2025
24 mar 2025

The Encyclopedia of Exoplanetary Systems

Global Authority in Exoplanetary Data

- **>7,400 confirmed objects** (<60 Jupiter masses)
- **>30,000 scientific publications** linked to the database

Community Impact

- **25,000+ monthly users** — *researchers, educators, enthusiasts*
- **1,900+ citations** — *in astrophysics journals*

Scope & Accessibility

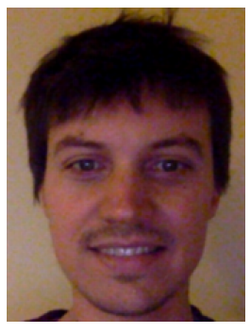
🔍 Includes:

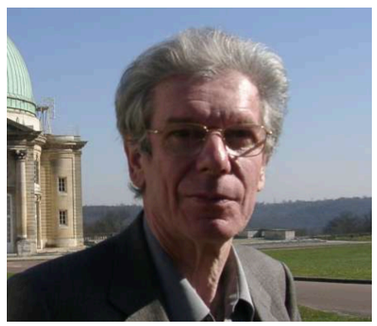
- Confirmed and candidate exoplanets
- Free-floating planetary-mass objects
- Systems with stars, brown dwarfs, and binaries
- Atmospheric data

The Team

Researchers

Q. Kral (PI), F. Roques, J. Schneider — P. Thébault (binary database)





Engineers

P.Y. Martin, U. Chosson, F. Henry

+ Expert science editorial committee — Transition to an Expert committee by field

The Catalogue

Jouvence of the website in 2023-2024

Home Catalogue Plots Tools EXOplanet.eu News Bibliography Meetings Links

Encyclopaedia of exoplanetary systems

This encyclopaedia provides the latest detections and data announced by professional astronomers on exoplanetary systems. It contains objects lighter than 60 masses of Jupiter, which orbit stars or are free-floating. It also provides a database on exoplanets in binary systems, a database on circumstellar disks, an exhaustive bibliography, a list of exoplanet-related meetings, and links to other resources on the subject.

Established in February 1995 Developed and maintained by the exoplanet TEAM

Last update: March 11, 2025 currently 7419 planets.

The catalog: Filter, sort, export

The plots: Online plotting tool

Recent News

Info

March 6, 2025

Over 100 new systems have been added to our planets-in-binaries database, representing a 30% increase (a machine-readable table of all systems can be found here)

Bibliography

Full bibliography of the catalogue

Last update: March 11, 2025

Planets in binaries

Binary systems and exoplanets

Last update: March 5, 2025

Other sites

Relevant professional web sites

Last update: Jan. 8, 2025

Researches

Ongoing Programmes and Future Projects

Meetings

Future and past meetings

View of planets around us

Polar plot of exoplanets

Jouvence of the website

MARCH 10, 2025 — MARCH 12, 2025 HAPPENING NOW

Gas Accretion in Planet formation (GAP)

Heidelberg, Deutschland

MARCH 10, 2025 — MARCH 14, 2025 HAPPENING NOW

Towards New Frontiers: The Astrochemical Journey from Young Stellar Nurseries to Exoplanets

Garching, Deutschland

MARCH 10, 2025 — MARCH 14, 2025 HAPPENING NOW

Lunar and Planetary Science Conference

Woodlands, TX, USA

The Catalogue

Jouvence of the website

Status ▾ | Detection ▾ | "confirmed" in planet_status | ? | Apply Filter

DETECTION METHOD COLOR LEGEND:

Primary Transit | Secondary Transit | Radial Velocity | Microlensing | Imaging | Astrometry | TTV | Timing | Kinematic | Other

X axis variable

Planetary Mass

show error bars

Use log scale

min | max

Y axis variable

Orbital Period

show error bars

Use log scale

min | max

Color variable

Size variable

Show grid

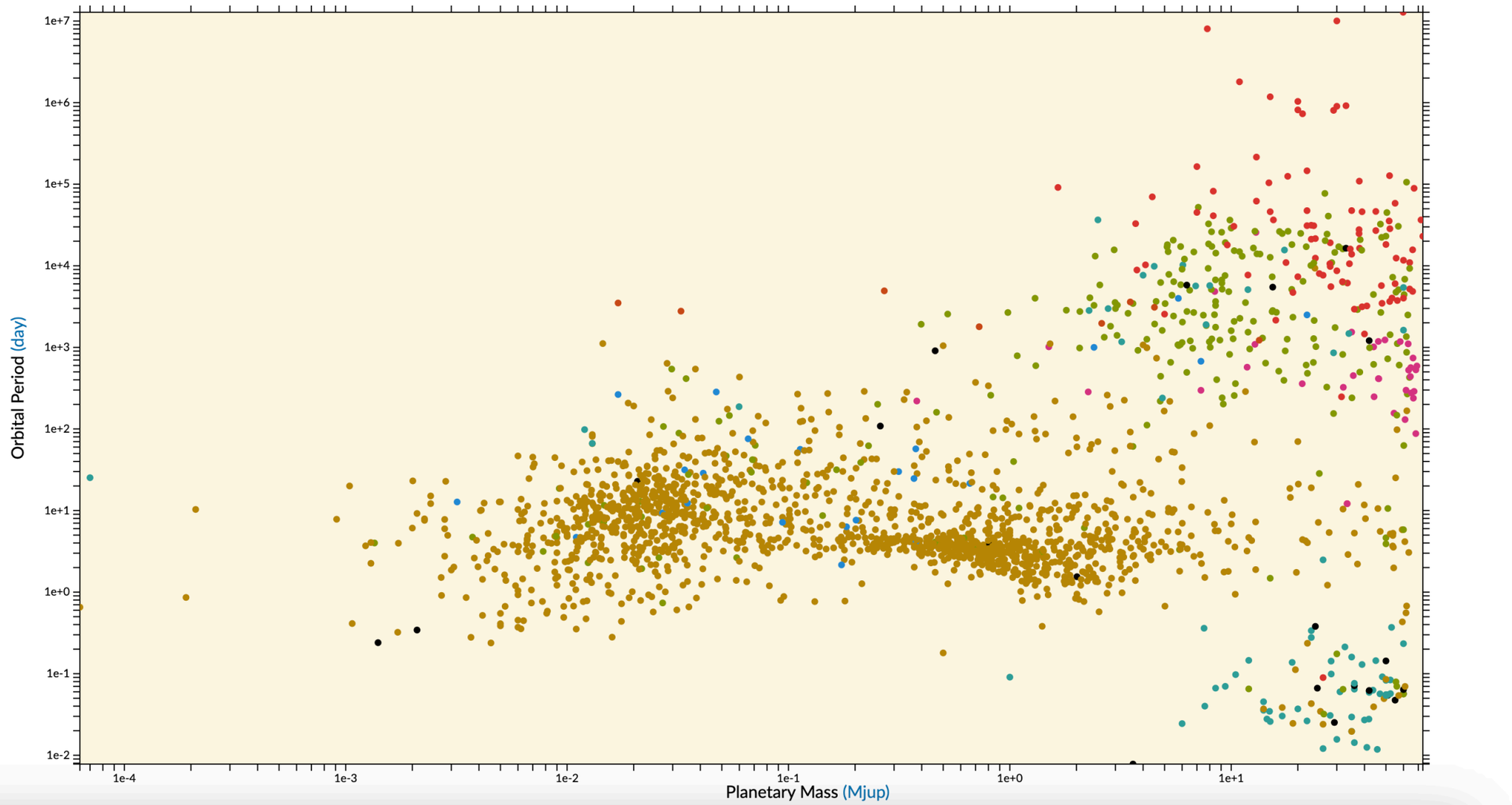
Manual Pan/Zoom

Show labels

Selection mode

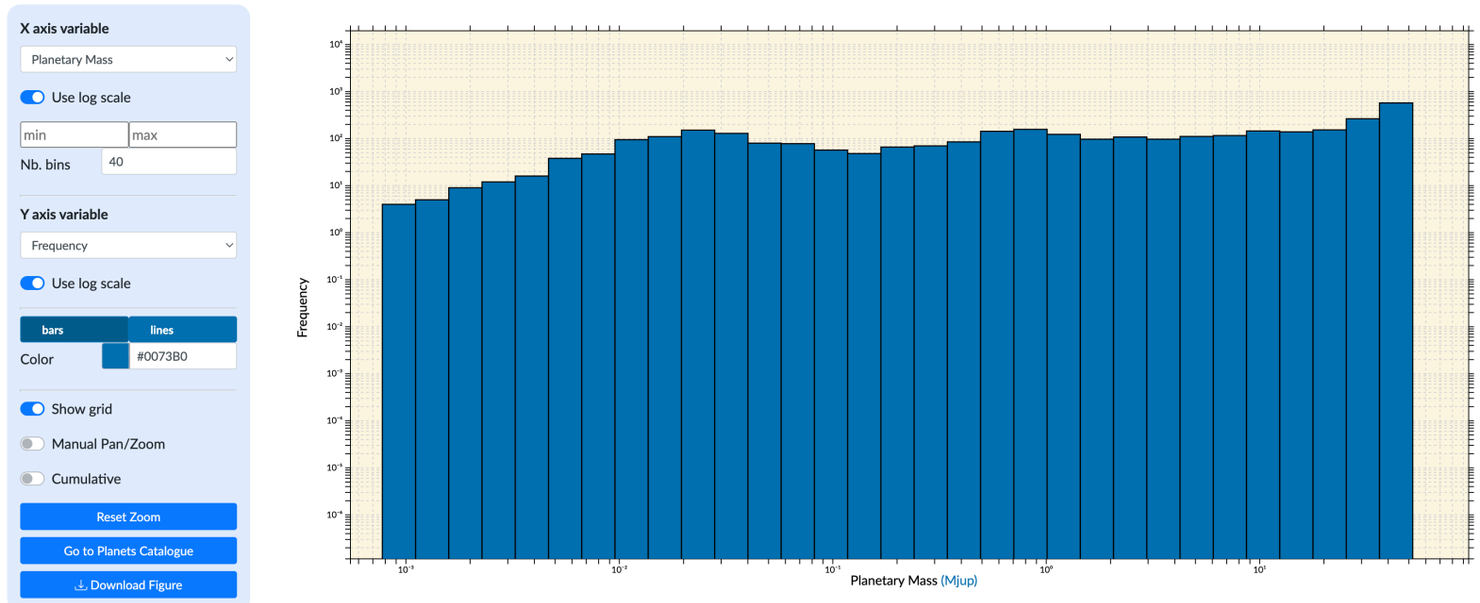
Reset Zoom

Go to Planets Catalogue

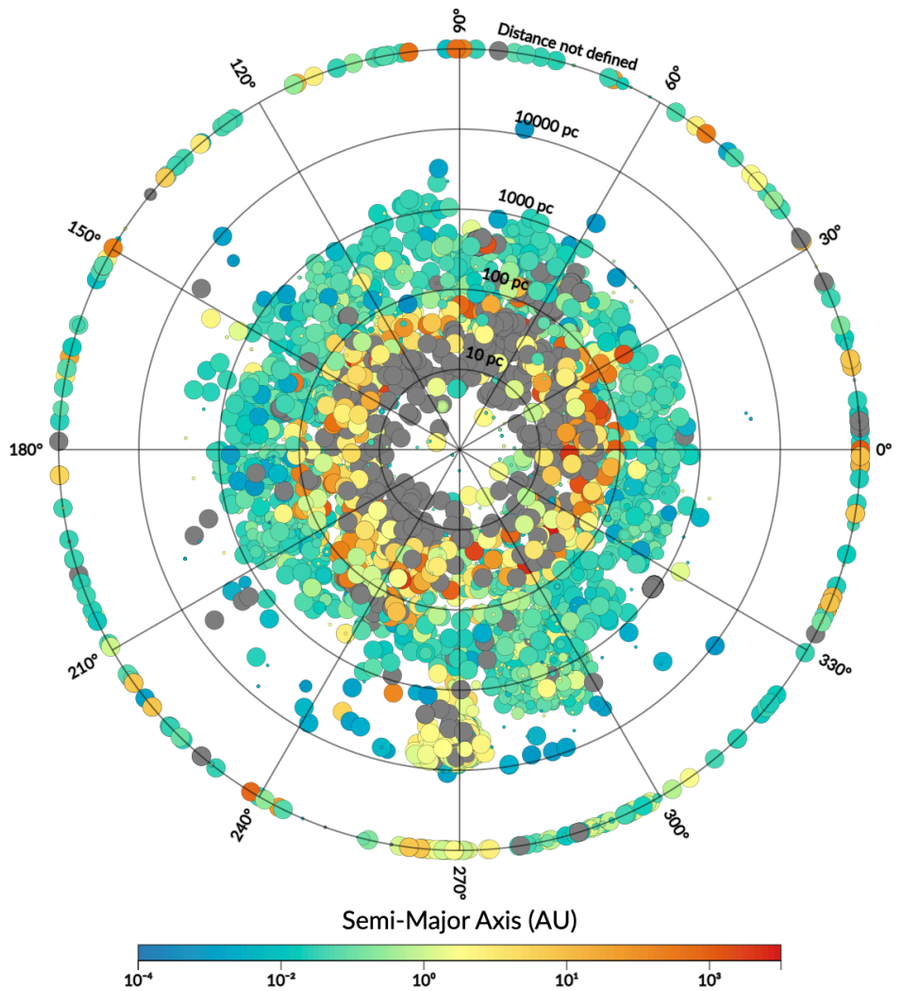


Other plots

Histograms



Polar plots



Can access:
28 stellar parameters
54 planet parameters

Code debt

Massive work accomplished to catch up with the website's technical debt

From python 2.7 to python 3.10

From Django 1.9 to Django 3.2

0 automatic tests to 22810

Clean management of the dependencies with npm (web) and poetry (Python)

From SVN to Gitlab

+many other modifications…

SEE TALK ABOUT TECHNICAL SIDE IN SEMI-HACKATHON SESSION
(Pierre-Yves Martin + Ulysse Chosson)

Massive recent update of Exoplanet.eu

Key Updates in 2024

✅ **Added 1,000+ new objects** in 2024

✅ **7428 confirmed objects** to date — **the largest database globally**

Comparison with NASA's Archive

📊 **Surpassed NASA's exoplanet count** even when applying their stricter criteria (we have >300 more objects):

- *No free-floating planetary-mass objects*
- *Mass limit: <30 Jupiter masses*

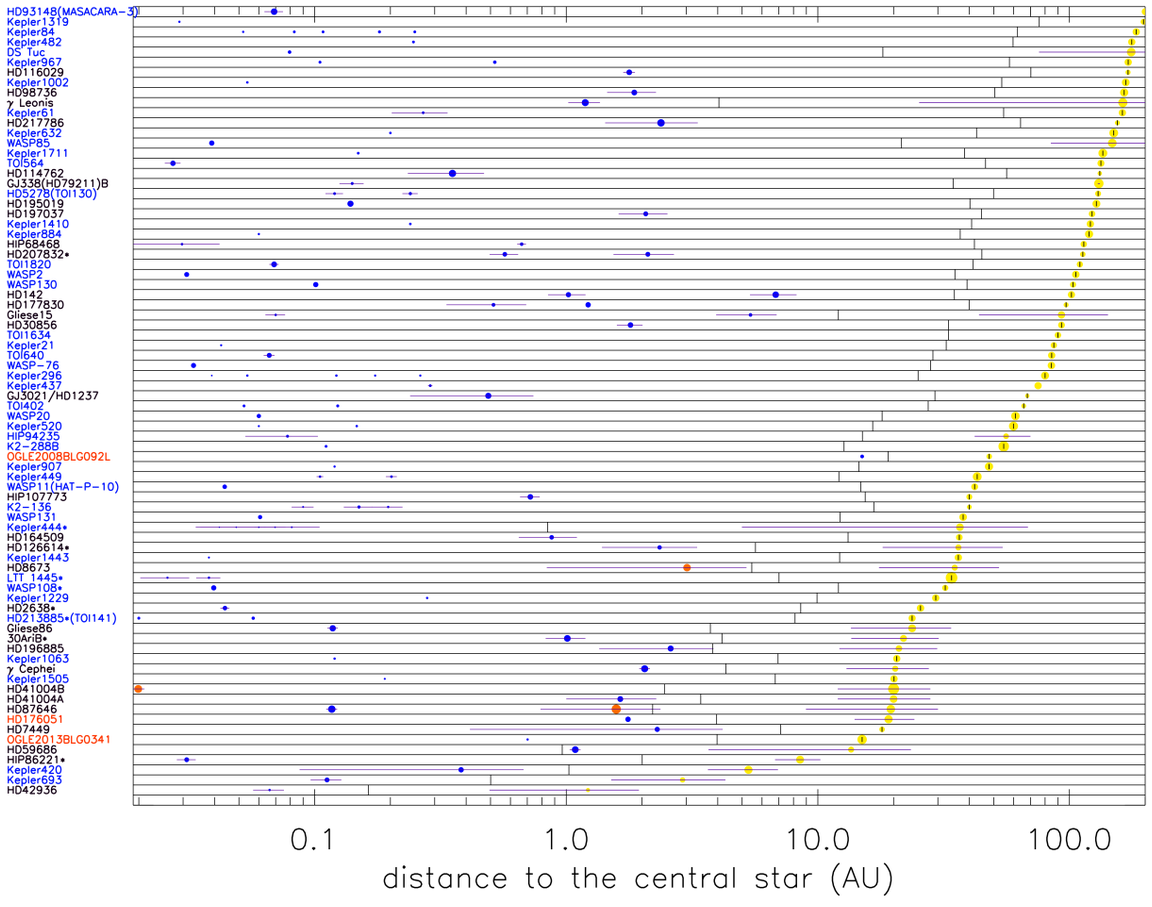
Major Breakthrough (a few days ago): Binary Systems

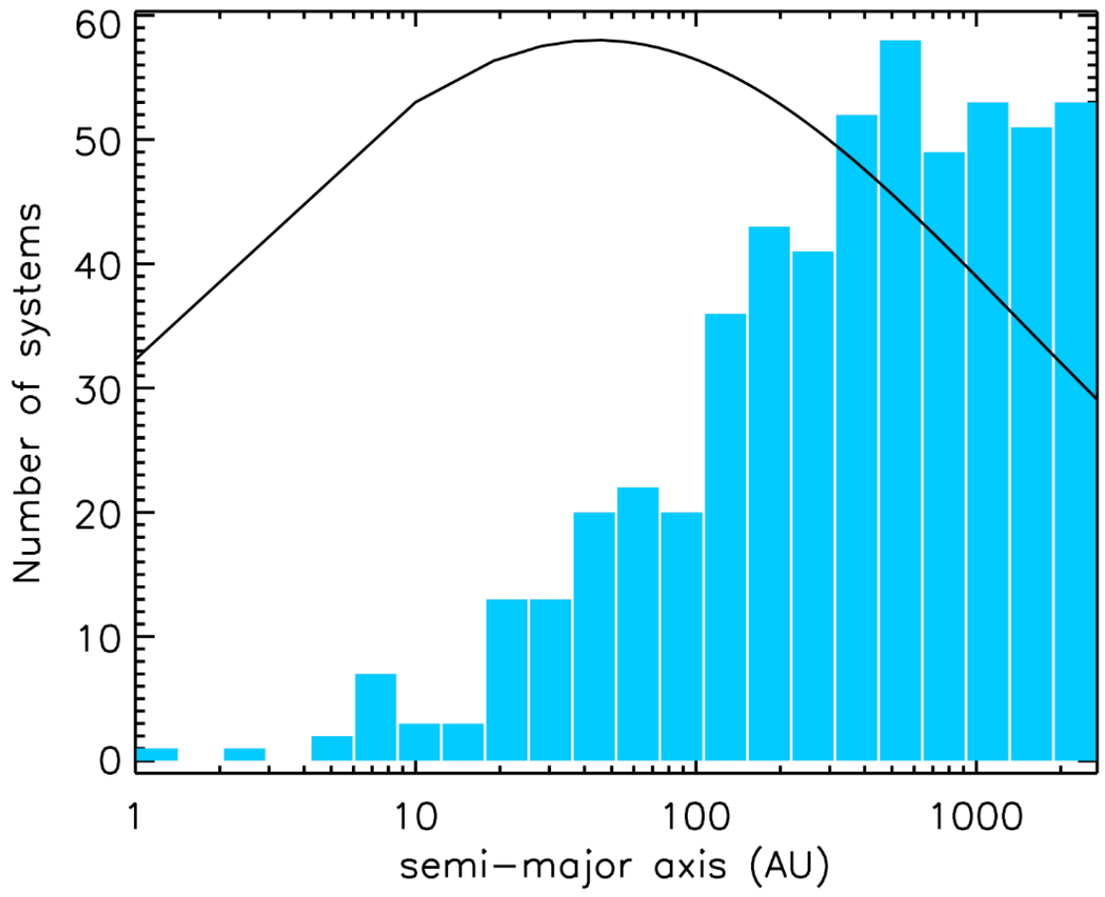
🌟 **60% increase** in exoplanets listed in binary/multiple-star systems

🌟 **545+ binary systems** now cataloged which is unique

The binary database

List all exoplanets on S-type orbits in binaries with separations up to 2000au (currently 545 systems) + 30 P-type (circumbinary)





Vision for the coming years

TWO main goals being tackled at the moment

1) From an exoplanet database to that of a planetary system

- Accourt for disks, exomoons, exocomets…
- Include some observation data?

2) Coping with massive increase of number of planets by 2030

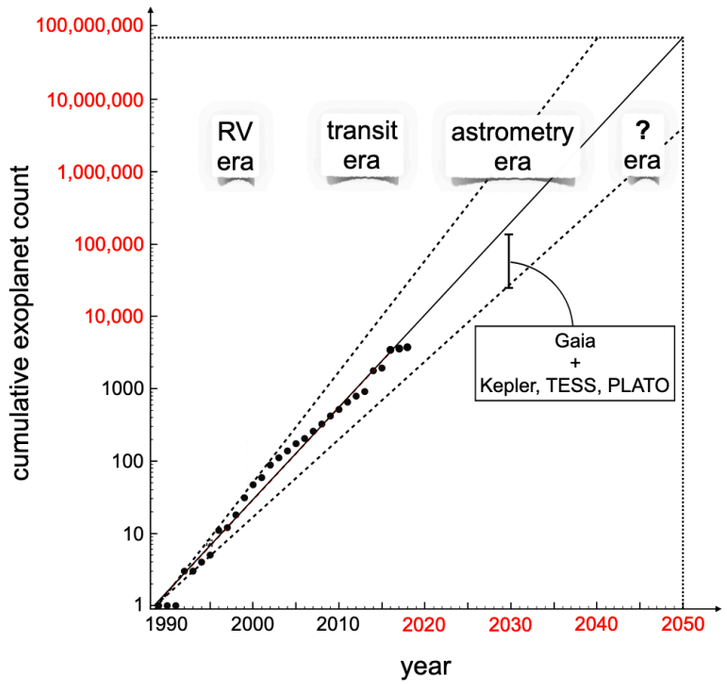
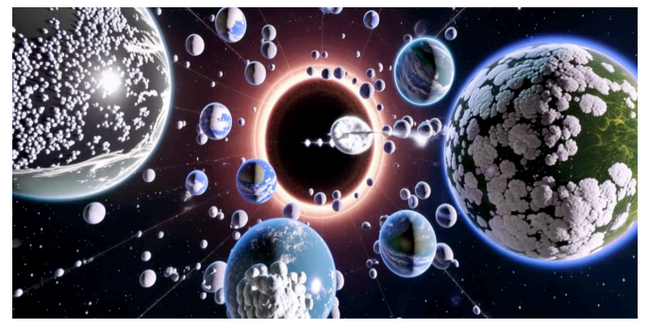


Fig. 1. Extrapolation of the exoplanet count into the year 2050. The black solid line is a fit to the data from 1988 to 2018, which hits a value of almost 100,000,000 in 2050. The dashed lines are the envelopes of the data. Red numbers along the abscissa and ordinate denote the ranges of extrapolation, for which no data is yet available. The vertical bar above the year 2030 refers to a combination of the currently known exoplanet population and expected exoplanet yields for Gaia, TESS, and PLATO as presented in the literature. The data points were taken from National Academies of Sciences & Medicine (2018) based on data by A. Weinberger/NASA Exoplanet Archive. Adapted and reproduced with permission from the National Academy of Sciences, Courtesy of the National Academies Press, Washington, D.C.

- 2030: **~100,000 planets** (>10x growth)
- 2040: **1,000,000+ planets** (if trends hold)

First Goal: From an exoplanet database to that of a planetary system

The Challenge



🌌 **Complexity of Planetary Systems**:

- Interactions between disks, planets, exomoons, and binary stars
- Diverse objects: exoplanets, brown dwarfs, exocomets, disks, multiple stars

🧩 **Data Overload makes visual representation complex**:

- Many parameters and complex relationships
- Risk of user confusion with inconsistent data representation

The Solution: EXODAM

🚀 **A new Data Model for Exoplanetary Systems**

- **Dynamic Frame**: Adapts to new objects/parameters *on the fly* (e.g., exomoons, disks)
- **Unified Hierarchy**: Organizes all system components (stars, planets, disks) into interconnected layers
- **Scalable**: Zero technical maintenance required for adding new parameters
- **Universal:** Could be used more globally for VO purposes

EXODAM

```
DOI : 12345exemples12345
objects :
    -   name : beta Pic
        exo_type : star
        alternate_names : bet Pic
        position :
            distance :
                value : 19.3
                unit : pc
                uncert : 0.2
            ra : 05:47:17.0
            dec : -51:03:59
        magnitude :
            magnitude_V : 3.86
        physical :
            mass :
                value : 1.73
                unit : Msun
                uncert : 0.05
            spectral_type : A6V
            age :
                value : 0.04
                unit : Gyr
                uncert : 0.004
    general :
        status : Confirmed
        discovered_date : 09/1994
        publication_status : R
        url_simbad : http://simbad.u-strasbg.fr/simbad/
-   name : beta Pic c
    exo_type : planet
    alternate_names : bet Pic c
    orbital :
            period :
                value : 1227.0
                unit : day
                uncert : 110
```

An example of an EXODAM data model JSON file

Publications: Could provide new planets (or disks…) using this data model —> the planets would be integrated in no time.

More flexibility: New parameters can be added at will without breaking the database —> can include parameters that were not measured before or add info on disks, exomoons, exocomets, observational data, …

In development: Ingestion of large lists of exoplanets from csv files using EXODAM

Scaling for the Exoplanet Data Tsunami (2030+)

Second goal: Cope with massive increase of number of planets by 2030+

The Challenge

⚠️ **Manual Data Entry**:

- Current: ~**7,400 planets** (hand-curated)
- 2030: **~100,000 planets** (>10x growth)
- 2040: **1,000,000+ planets** (if trends hold)

📈 **Unsustainable Workflow**:

- Daily manual updates → *impossible at scale*
- Risk of errors, delays, and incomplete data

Scaling for the Exoplanet Data Tsunami (2030+)

Second goal: Cope with massive increase of number of planets by 2030+

The Solution: Automate & Democratize

🚀 EXODAM as the Universal Standard:

- **Machine-Readable Data**: Pre-formatted templates for users to submit their list of new data
- **Community-Driven Uploads**:
  - *Dropbox portal* for users to submit data + publications
  - Automated validation + human cross-check

⚡ Bulk Ingestion:

- Pre-negotiate pipelines with missions (e.g., **PLATO's**)
- AI-assisted research, tagging, or relationship mapping?

Clarity in Complexity: A User-Centric Exoplanet Portal

REACH a Holistic System View

🌐 Unified System Pages

- *All components in one place*: planets, stars, disks, exocomets, exomoons.
- Interactive 3D environment (EXO-3D) showing **different components** (e.g., disk, exoplanet, binary star orbits, …).

🔍 Specialized Sub-Catalogues with Tailored Access for Research Needs

- **Atmospheres** (spectra, chemistry)🌪️
- **Disks** (protoplanetary/debris)🌀
- **Brown Dwarfs** 🟤
- **Free-Floating Planets** 🪐
- **Binary Systems** 💫
- **Exocomets** ☄️

In the future: sub-catalogues + ACCESS VIA DEDICATED API (compatible with EXODAM)

The disk database (restricted access for now)

See all definitions

See all units

DISK

identify 2 parameters

object name	49 Ceti
alternate object names	['HD-9672']

internal 1 parameters

object status	confirmed

orbital 1 parameters

inclination	73 *deg*

geometric 2 parameters

Half width of the disk	1.0 *arcsec*
Mean radius of the disk	2.37 *arcsec*

atmospheric 1 parameters

geometric albedo	0.17

observational 2 parameters

Fractional luminsoity of the disk	0.0009
Surface brightness peak	0.000129 *Jy/arcsec^2*

STAR

identify 3 parameters

object name	49 Ceti
Moving Group	Argus association
First detection date	2016

internal 2 parameters

rel_star_id	None
object status	confirmed

physical 3 parameters

age	40 *Gyr*
effective temperature	9970 *K*
spectral type	A1V

position 3 parameters

right ascension	1 *deg*
declination	-15 *deg*
distance	59 *pc*

magnitude 2 parameters

magnitude_R	5.6
magnitude in V band	5.6

observational 2 parameters

flux	10.18 *mag*
luminosity	20 *?*

EXOplanet.eu

5418 exoplanets so far

For the use of this catalog README first

Exoplanet.eu V2.1.2-beta

Who are we?

exoplanet team
about the catalog
help - FAQ
legal notice

Our partners

Our community

Report a problem
contact us

Tools of exoplanet.eu

Current online tools

AMDf-stability of the system HD 136352

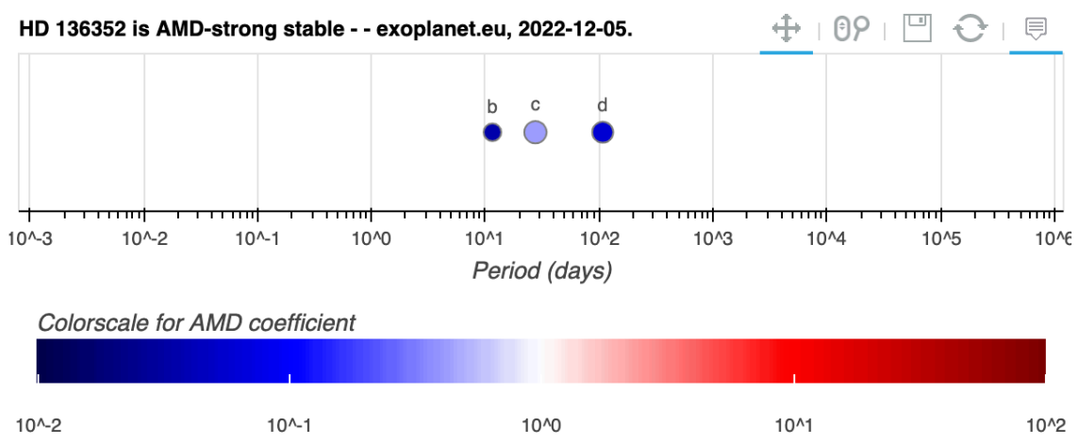
Parameters of the system:

	value	min err	max err	
HD 136352 b				
eccent (e) :	0.079	0.053	0.068	
mass (m) :	0.01454	0.00142	0.00142	MJup
period (T) :	11.57779	0.001	0.001	day
HD 136352 c				
eccent (e) :	0.037	0.026	0.039	
mass (m) :	0.03552	0.00217	0.0023	MJup
period (T) :	27.5909	0.0031	0.028	day
HD 136352 d				
eccent (e) :	0.075	0.053	0.085	
mass (m) :	0.02775	0.00296	0.00296	MJup
period (T) :	107.63	0.19	0.19	day

Update Graph

Set Errors to Zero

Restore System



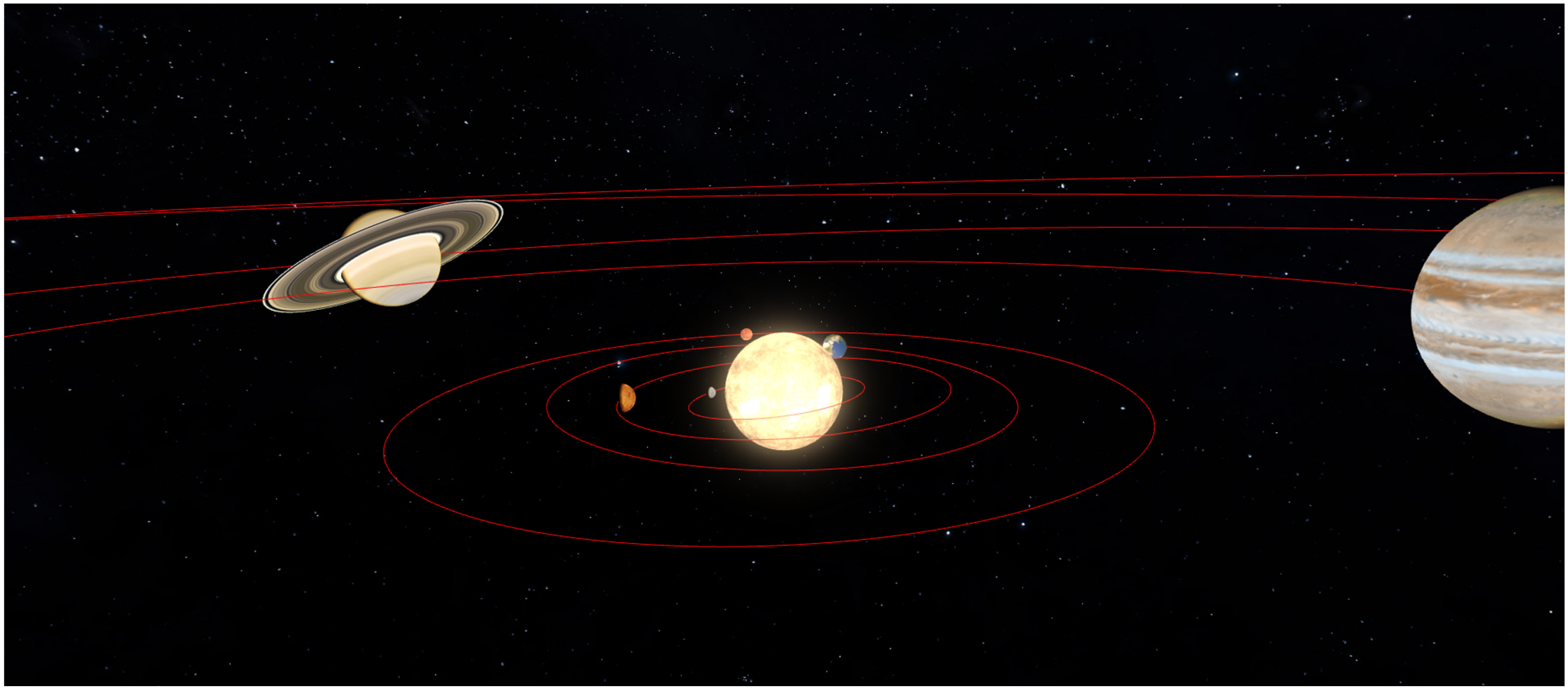
Tool developed to assess the stability of a planetary system over long timescales (from Laskar & Petit, 2017).

+other tools: GCM 1-D, Observability Predictor, Exoris

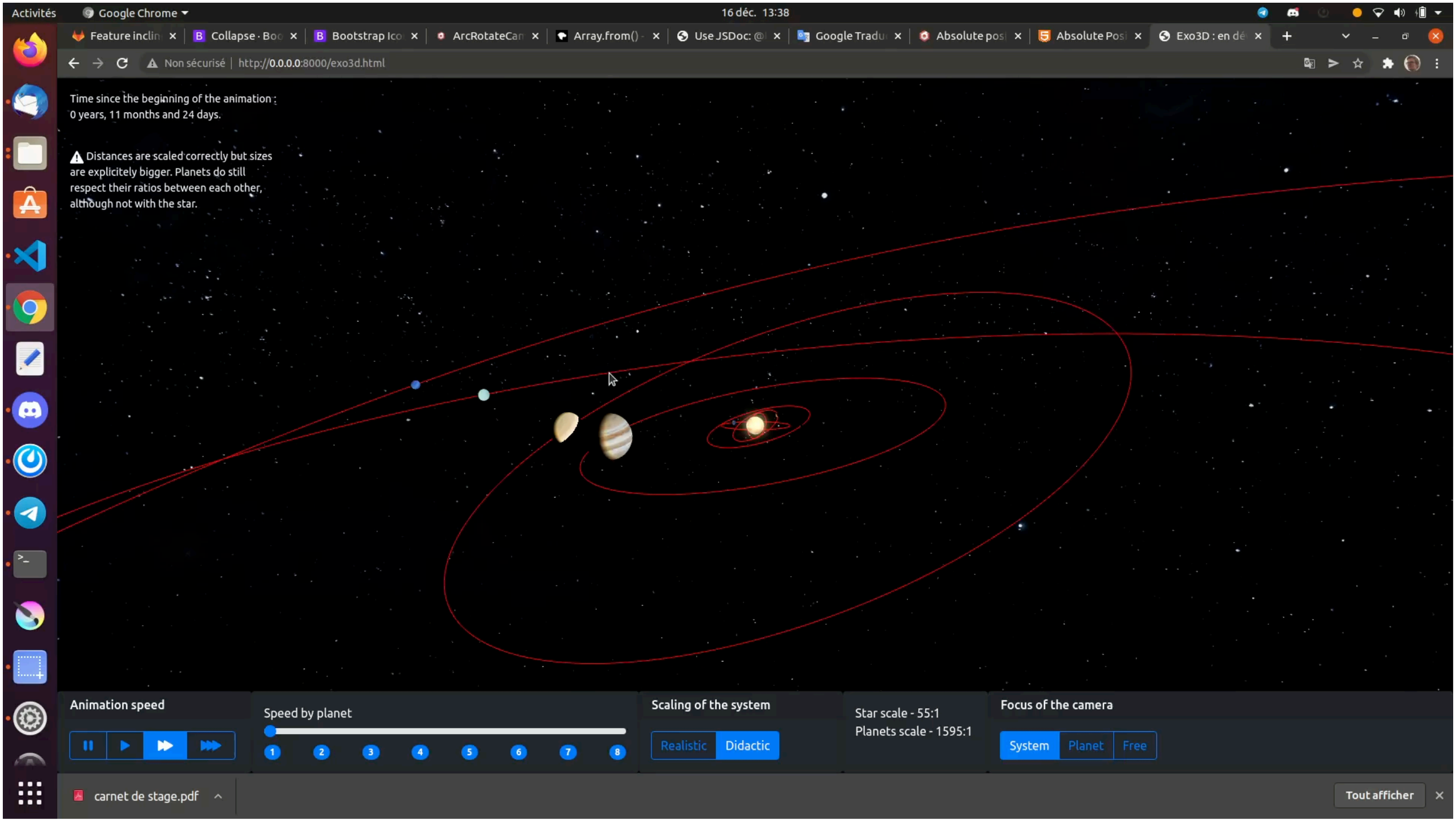
Exo3D

New tool developed by the IT team of exoplanet.eu (our ANR funded a trainee to do that, T. Bedrine)

A snapshot of the tool:



The Exo-3D tool in video

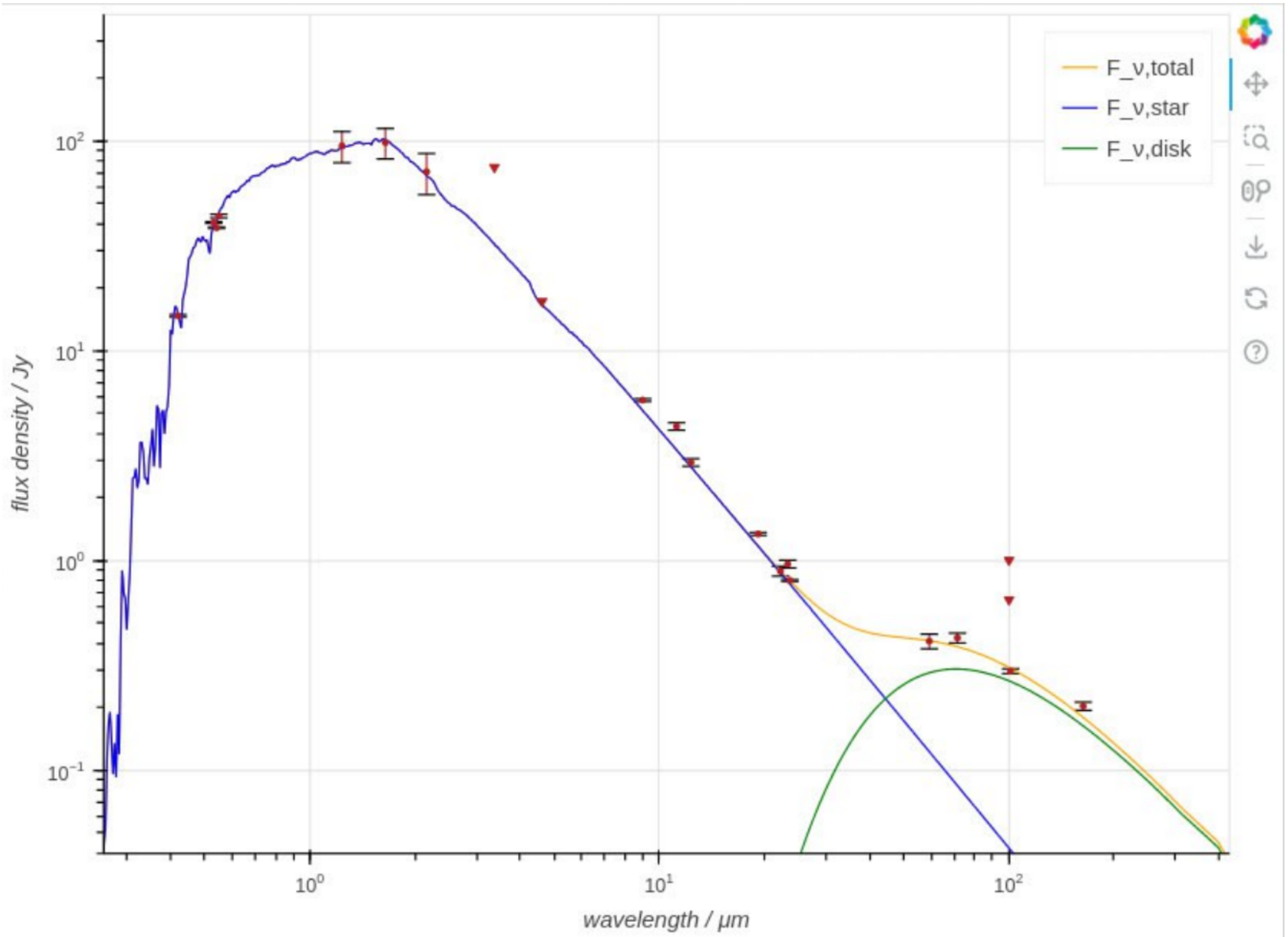


Accessible in the browser and in Virtual Reality and soon in Augmented Reality (with ex4edu)

The ExoDisk tool

Disk SED Predictor

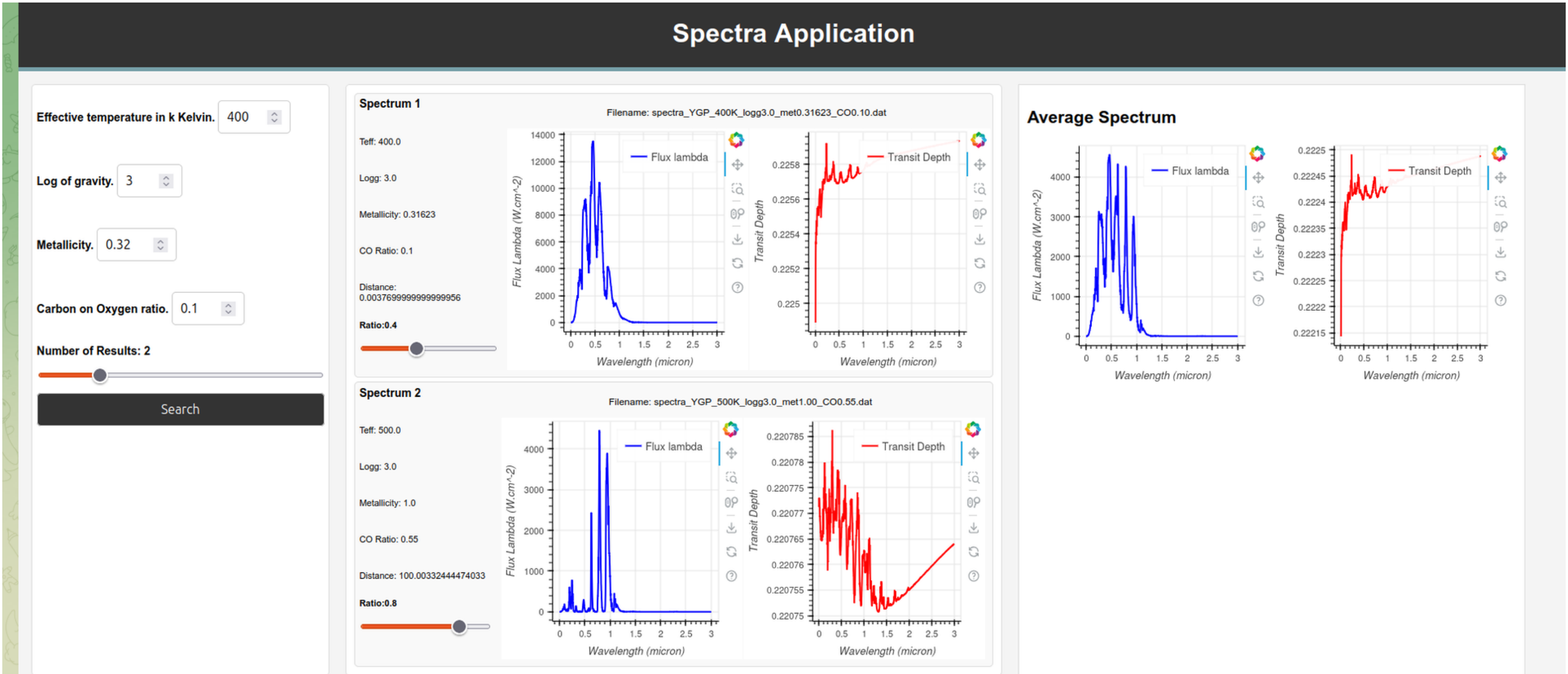
- **Radiative transfer tool for disk observations**
- **Trainee-led** → Aids ALMA/observatory planning
- **Built with Bokeh** → Fast dev + secure updates
- **Requires GRATeR code coupling** (Partner: IPAG)



The ExoREM tool

ExoREM: Exoplanet Spectrum Predictor

- **JWST transit planning tool**
- **Trainee-led development**
- **Next steps**: Testing + deployment on *exoplanet.eu*



The scholar website

Questions Cours EXOplanet.eu Base de données Activités en classe Boite à outils

en | fr

ACCUEIL

Que vous soyez enseignant ou simplement curieux, vous trouverez ici tous les chemins pour explorer le monde des exoplanètes :

- Des questions sur les exoplanètes
- Des cours sur les exoplanètes
- La base de données
- Des activités en classe
- La boite à outils des chercheurs d'exoplanètes

Depuis une trentaine d'années, les connaissances s'accumulent. Mais pour commencer, écoutez un chercheur d'exoplanètes présenter les premières étapes de cette quête et son lot de surprises, la plus importante étant qu'il y a... Des planètes partout.

COMPTEUR D'EXOPLANÈTES

Jeudi 12 juin 2024
Planètes candidates et confirmées
6164

TABLE DES SYSTÈMES

Systèmes avec 1 planète	4266
Systèmes avec 2 planètes	546
Systèmes avec 3 planètes	151
Systèmes avec 4 planètes	52
Systèmes avec 5 planètes	16
Systèmes avec 6 planètes	9
Systèmes avec 7 planètes	1
Systèmes avec 8 planètes	1

In development. **Funding by PEPR Origines + EXO4Edu (internationalisation)**

FRANCE 2030 PROGRAMME DE RECHERCHE ORIGINES

ex4edu

The Road Ahead: Scaling exoplanet.eu

Great Showcase for OBSPM but Challenges on the way

⚠️ **Team Capacity**:

- **3-person team** → *2 retired (emeritus)*
- **Urgent need**: Hire engineers + scientists to manage growth

📈 **Data Deluge**:

- **100,000+ exoplanets expected by 2030 (Manual processes → *unsustainable)***
- *All exoplanetary components to ingest (e.g. disks, exocomets, …)*

Immediate Priorities

🚀 **Deploy & Stabilize**:

- Finish and deploy tools (ExoREM, Exo3D, ExoDisk)
- Finalize integration of **EXODAM data model** in backend
- Launch **community upload portal** (dropbox, API, csv ingestion)

💡 **Leverage Community**:

- Crowdsource ideas (e.g., **RV/transit data integrations**)
- Gather experts on each subfields to secure sets of data

Call to Action

🔧 **We Need**:

- **Engineers**: Backend scaling (EXODAM), AI/automation, Frontend development (Tools)
- **Scientists**: Data ingestion/validation, Tool developments for users

🌍 **Join Us**:

- Collaborate with us if you are interested