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ExoClass & SysClass: A Compact Code for Classifying Exoplanets and Planetary Systems

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◆ Why Do We Need a Classification System for Exoplanets and Planetary Systems?

While a G2V stellar classification instantly conveys mass, temperature, and the spectral properties of a star, no such standard exists for exoplanets or their systems.
Current descriptors – such as "hot Neptune," "super-Earth," or "mini-Jupiter" – are informal, ambiguous, and inconsistent. They lack precise meaning, overlap in parameter space, and hinder comparison.

A standardized, compact classification system would:
- ✓ Enhance clarity and comparability
- ✓ Support automated catalogues and AI-driven analysis
- ✓ Foster universal communication across datasets and missions

ExoClass and *SysClass* aim to fill this gap – with four concise parameters each, capturing the essence of a planet or a planetary system.

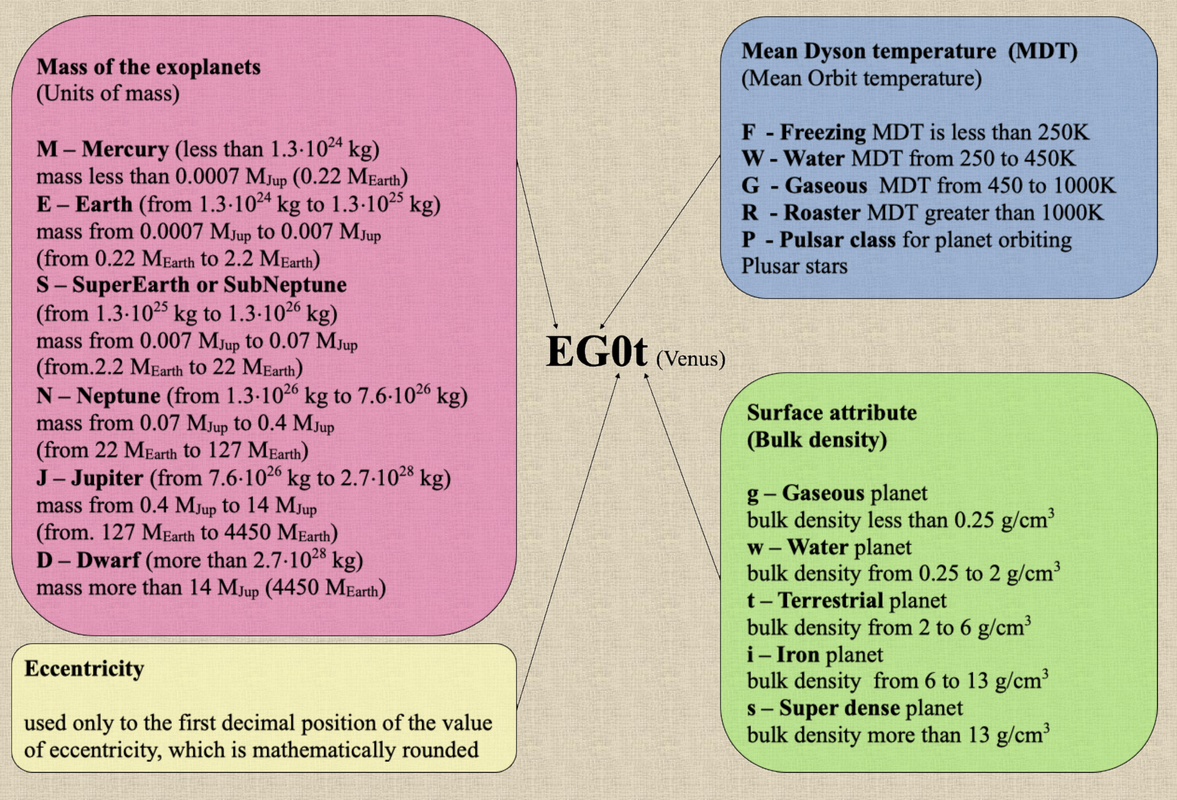


Figure 1: Summary of the ExoClass system, showing physical ranges used to classify planetary mass, temperature, eccentricity, and surface. This framework enables rapid comparison and cataloging across diverse exoplanet populations.

◆ Exoplanet Classification – ExoClass

We propose a four-parameter classification code that captures the most essential physical characteristics of an exoplanet in a compact form. This allows for instant recognition, easier comparison, and systematic cataloguing.
The parameters are:

Mass class
Exoplanets are grouped logarithmically by mass. Each step represents a factor of ten. For example, Earth (*E*), Neptune-like (*N*), and Jupiter-like (*J*) masses form the base mass classes.

Temperature class
Based on the mean Dyson temperature – i.e., the average temperature of an artificial Dyson sphere placed at the planet's orbit, accounting for eccentricity using Kepler's second law.
The temperature classes reflect physical states of water. For example, planets located in the habitable zone typically fall into the *W* class (Water).

Eccentricity
Encoded using a single digit representing the rounded first decimal place of the planet's eccentricity (e.g., 0.03 → 0, 0.14 → 1).

Surface class
Determined from mean density and expected surface properties. For example, '*t*' denotes terrestrial rocky surfaces; '*g*' stands for gas giants; and '*w*' indicates water/ocean surface.

Examples:
Earth → *EW0t* Neptune → *NF0w* 55 Cancri e → *ER0i*
This code brings clarity to planetary diversity and provides a flexible basis for large-scale exoplanetary studies.

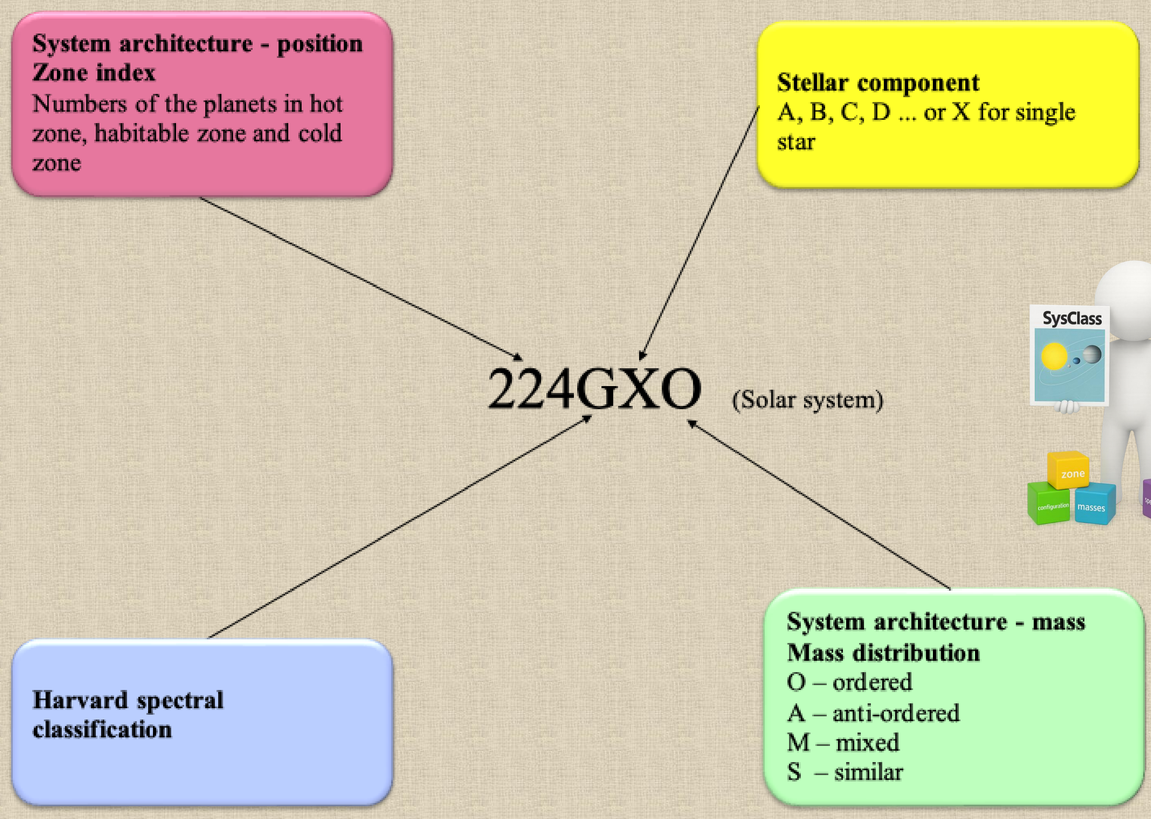


Figure 2: The SysClass code describes planetary systems using four parameters: zone index (number of planets in hot, habitable, and cold zones), stellar spectral class, stellar multiplicity, and planetary mass distribution (similar, ordered, anti-ordered, or mixed).

◆ Planetary System Classification – SysClass

We propose a four-parameter code designed to describe the key architectural features of planetary systems in a concise and comparable way. The SysClass code captures not only the number and location of planets but also stellar characteristics and mass distribution patterns.
The parameters are:

Zone Index (ZI)
A three-digit number indicating how many planets lie in each of the following zones: *hot (inner) zone*, *habitable zone* and *cold (outer) zone*. For example, 224 indicates two planets in the hot zone, two in the habitable zone, and four in the cold zone.

Spectral Class of the Star
The stellar spectral type based on the Harvard classification (e.g., G, K, M).

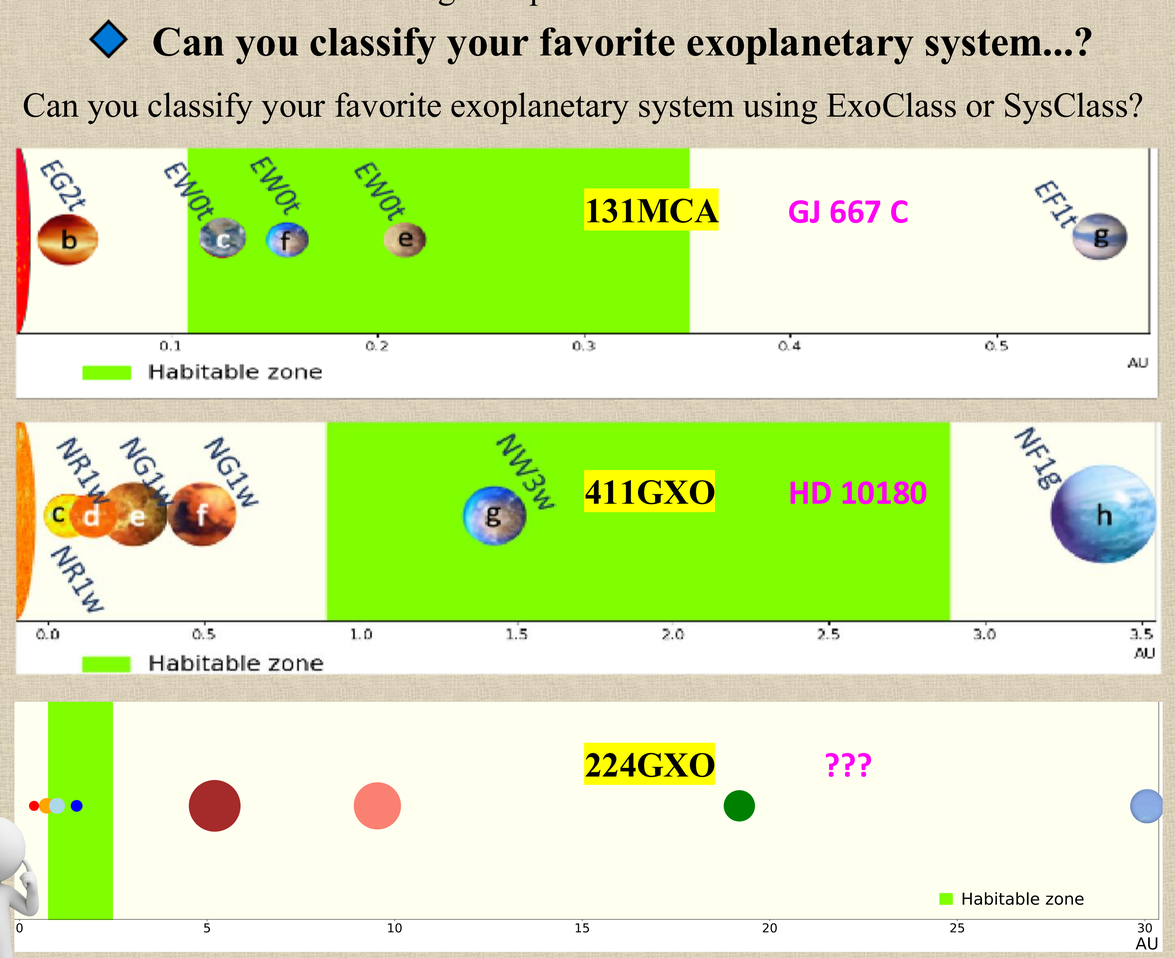
Stellar Configuration
A symbol identifying the stellar multiplicity, where X = single star, *e.g.*, AB or BC = binary systems with planet-hosting components.

Mass Architecture
Describes how planetary masses are distributed within the system, where
S = Similar masses; *O* = Ordered (mass increases with orbital distance);
A = Anti-ordered (mass decreases outward); *M* = Mixed masses.

Examples:
Solar System → *224GXO* 55 Cancri system → *311KXM*
The SysClass code allows quick comparison of system architectures and supports automated classification in large exoplanet databases.

◆ Can you classify your favorite exoplanetary system...?

Can you classify your favorite exoplanetary system using ExoClass or SysClass?



Solar system: SysClass *224GXO*, Mercury *MG2t*,Venus *EG0t*, Earth *EW0t*, Mars *MW1t*, Jupiter *JF0w*, Saturn *NF1w*, Uranus *SF0w*, Neptune *NF0w*.

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