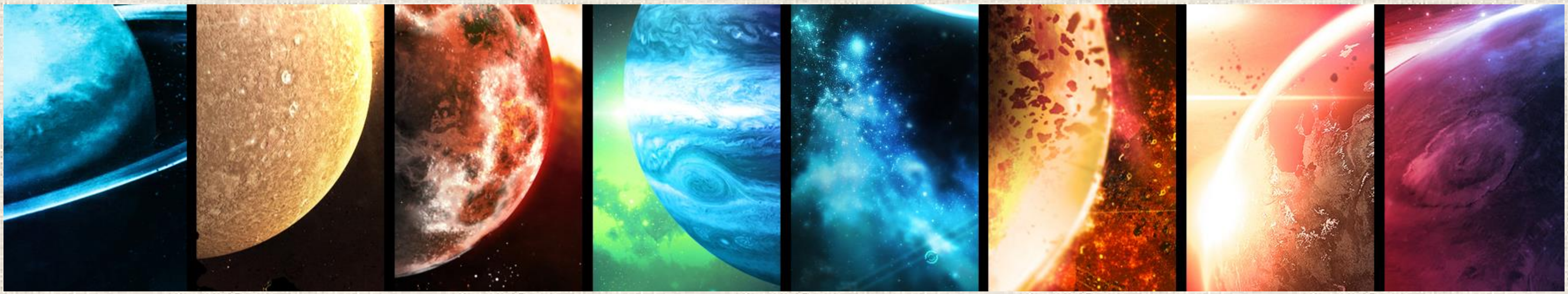
Do we need a system of classification for extrasolar planets?



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A brief history of stellar classification

1814

Joseph Fraunhofer invented the spectroscope and was the first to observe solar and stellar spectra.

1860-1870

Pietro Angelo Secchi classified the spectra of stars into two classes, basically the early I and the late-types II. In 1866 he added what are now the M-types III, and two years later he identified some faint red stars as type IV, the carbon stars. Later yet he felt compelled to separate some emission-line stars into a further class, V.

1881-1890

Williamina Fleming classified more than 10,000 star. It used a scheme in which the previously used Secchi classes (I to IV) were divided into more specific classes, given letters from A to N. Also, the letters O, P and Q were used, O for stars whose spectra consisted mainly of bright lines, P for planetary nebulae, and Q for stars not fitting into any other class.

A brief history of stellar classification

Around 1890

Joseph Norman Lockyer offered his own spectral classification scheme. The differentiation of stars into ascending and descending temperature branches was based on his “meteoritic hypothesis” for the origin and subsequent evolution of stars. His classifications were never generally accepted, he did at least distinguish the spectra of giants and supergiants.

1943-1953

A new system of stellar spectral classification MKK, was introduced in 1943 by Morgan, Keenan, and Kellman. This two-dimensional (temperature and luminosity) classification scheme is based on spectral lines sensitive to stellar temperature and surface gravity which is related to luminosity (whilst the Harvard classification is based on surface temperature only). Later, in 1953, after some revisions of standard stars and classification criteria, the scheme was named the Morgan–Keenan classification, or MK and this system remains in modern use today.

A brief history of planet classification

1969

Peter Van de Kamp – Barnard star

1988

Bruce Campbell, Gordon A.H. Walker – Stephenson Yang and γCephei

1991

Andrew Geoffrey Lyne – pulsar planet ? around PSR 1829-10

1992

Aleksander Wolszczan and Dale Frail – a multi-planet planetary system around the millisecond pulsar PSR 1257+12

1995

Michel Mayor and Didier Queloz – 51 Peg b

Today

Almost two thousand planets and thousands of planet-candidates have been discovered since then.

A brief history of planet classification

2003

David Sudarsky, Adam Burrows, and Ivan Hubeny created the so called Sudarsky's classification of extrasolar gas giant planets, for the purpose of predicting their appearance based on their temperature. Gas giants are split into five classes (numbered using Roman numerals) according to their modelled physical atmospheric properties.

2007

Simone Marchi used as many inputs as possible for the analysis, in particular the planetary mass, semi-major axis, eccentricity, stellar mass and stellar metallicity. He identify the best procedure to follow: a multivariate statistical analysis (PCA) to find the most important variables, and then hierarchical cluster analysis. His best solution consists of five clusters.

A brief history of planet classification

2009

Lundock et al. had acquired spectra for all of the solar system planets and many smaller bodies. The spectra are divided by their characteristic shapes into three distinct groups: gas planets, soil planets, and ice planets. Venus represents a fourth possible group.

2012

Eva Plávalová proposed an extrasolar planet taxonomy scale with four main parameters which cover the mass, semi-major axis, temperature, eccentricity, plus one optional parameter, surface parameter, which is not always known.

System of planets classification

Mass of the EPs
(Units of the mass)

M– less than 0.002 M_{Jup}
E – from 0.002 to 0.03 M_{Jup}
N – from 0.03 to 0.6 M_{Jup}
J – from 0.6 to 5 M_{Jup}
S – from 5 to15 M_{Jup}
D – more than 15 M_{Jup}

Semi-major axis

distance from its parent star (semi-major axis) described in logarithm with a base 10
e.g.:
for Earth it is 0
for Mercury it is -0.4
for semi-major axis 0.05 AU is -1.3

M0.2W1t (Mars)

Mean Dyson temperature (K)
(Mean Orbit temperature)

F – to 250 K
W – from 250 to 450 K
G – from 450 to 1000 K
R – higher than 1000 K
P – pulsar class

Eccentricity

used to only the first decimal position of the value of eccentricity, which is rounded

Surface attribute

t – Terrestrial planet
g – Gaseous planet
i – Ice planet

System of planets classification

All extrasolar planets:	1897	
Classified planets:	1492	78,65%

The taxonomy scale of extrasolar planets for which we know the values for mass, semi-major axis, and eccentricity can be determined along with the values for the radius and effective temperature of their parent stars.

System of planets classification

Planet	Classification code	Minimal code
Solar system		
Mercury	M-0.4G2t	MG
Venus	E-0.1G0t	EG
Earth	E0W0t	EW
Mars	M0.2W1t	MW
Jupiter	J0.7F0g	JF
Saturn	N1F1g	NF
Uranus	N1.3F0i	NF
Neptune	N1.5F0i	NF

Planet	Classification code	Minimal code
Solar system		
55 Cnc b	J-0.9R0	JR
55 Cnc c	N-0.6G1	NG
55 Cnc d	J0.8F0	JF
55 Cnc e	E-1.8R1	ER
55 Cnc f	N-0.1W0	NW

System of planets classification

Planet	Classifica-tion code	Minimal code
Solar system		
Mercury	M-0.4G2t	MG
Venus	E-0.1G0t	EG
Earth	E0W0t	EW
Mars	M0.2W1t	MW
Jupiter	J0.7F0g	JF
Saturn	N1F1g	NF
Uranus	N1.3F0i	NF
Neptune	N1.5F0i	NF

Planet	Classifica-tion code	Minimal code
Solar system		
51 Peg b	N-1.3R0	NR
11 Com b	D0.1R2	DR
14 And b	S-0.1R0	SR
75 Cet b	J0.3G	JG
Kepler 9b	N-0.8R1	NR
Kepler 9c	N-0.6G1	NG
CoRoT-9 b	J-0.4G1	JG
HD 117207 b	J0.6F2	JF

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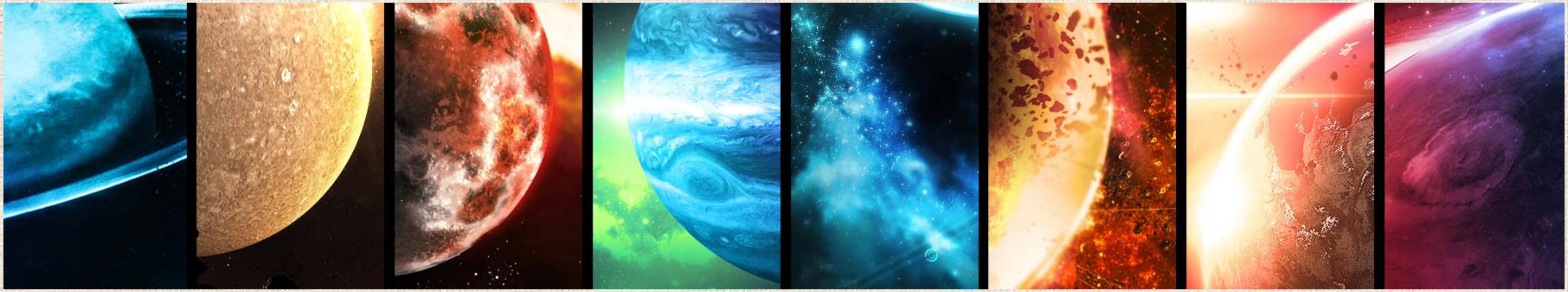

Thank you for your attention.