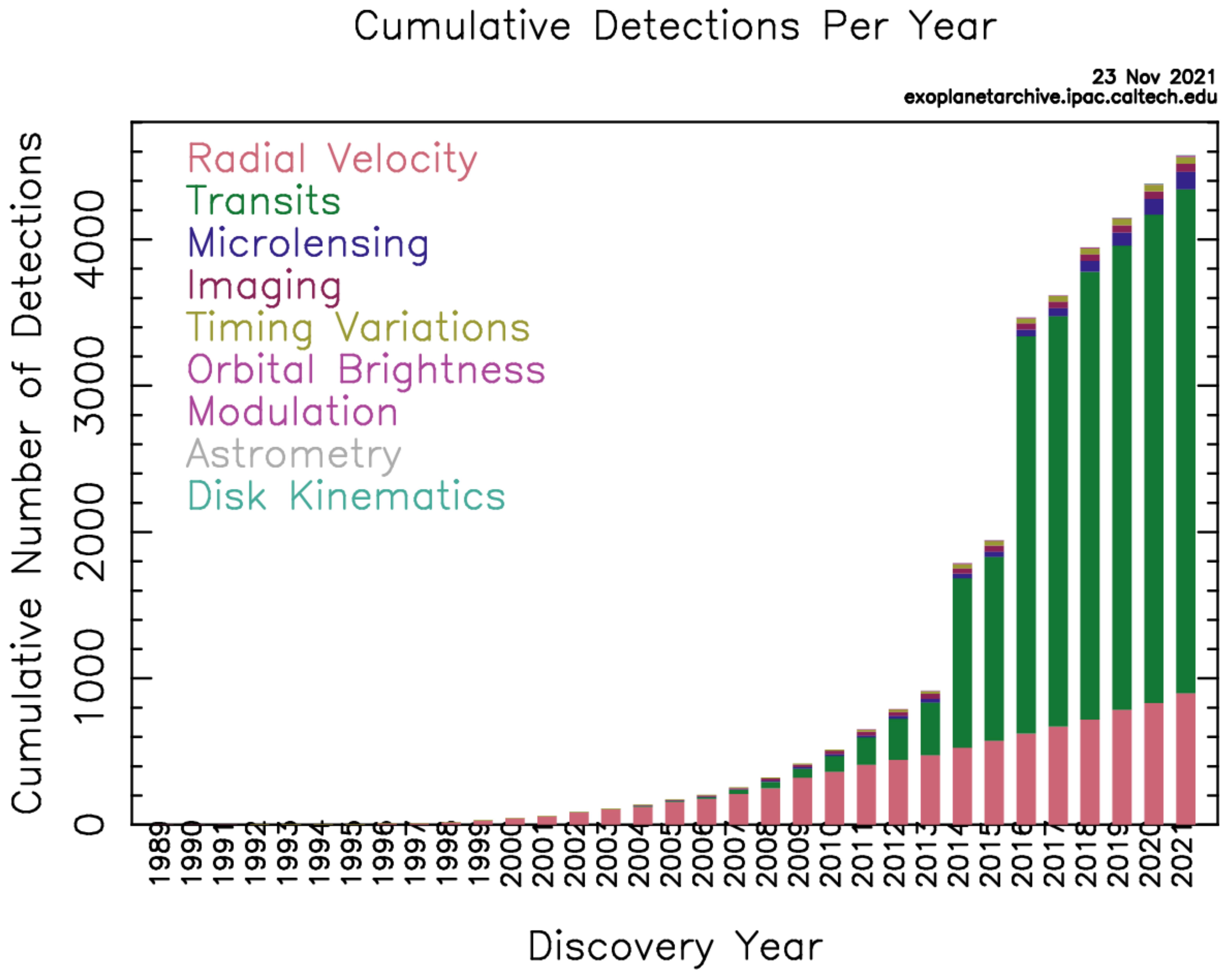
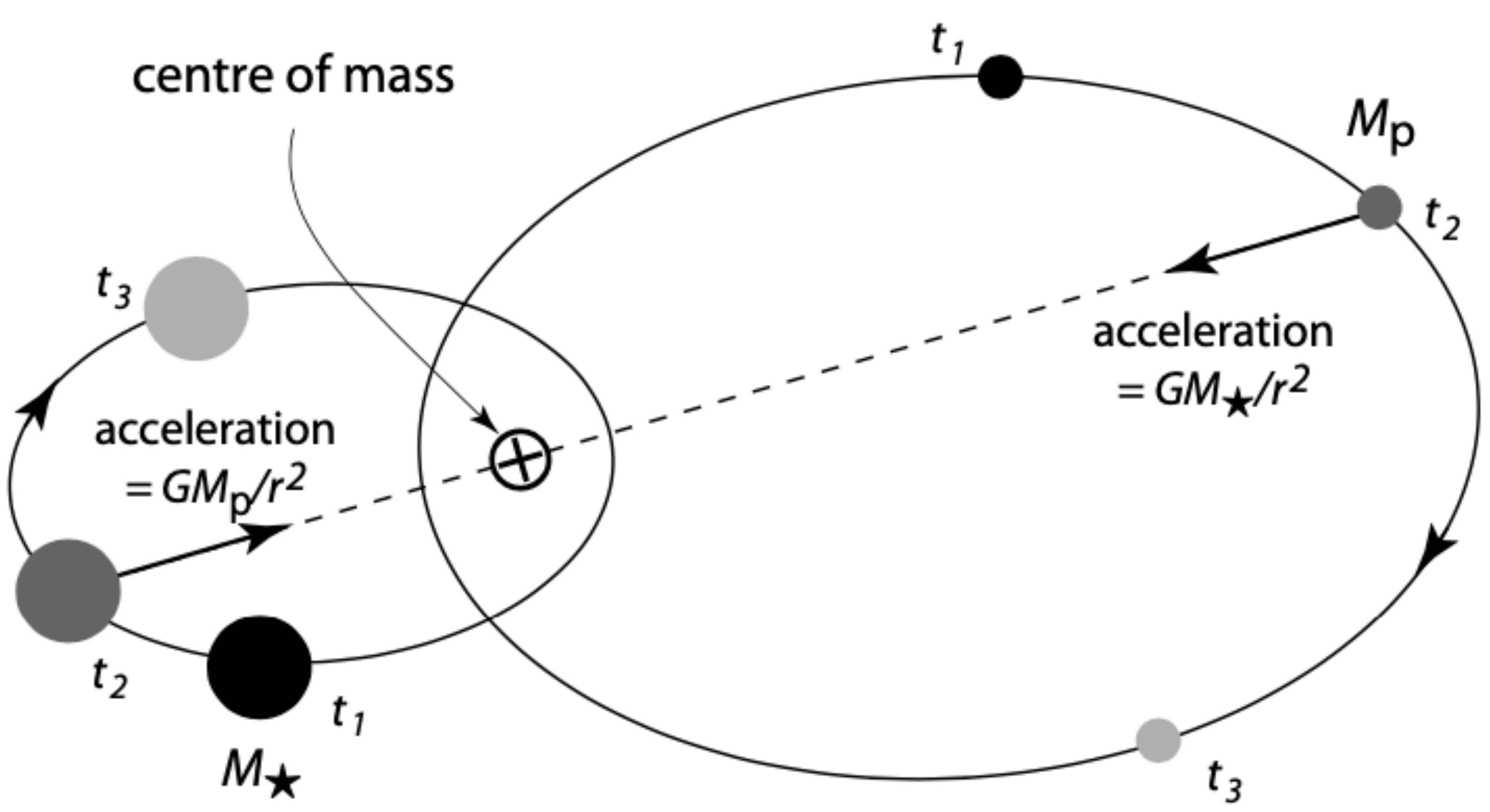
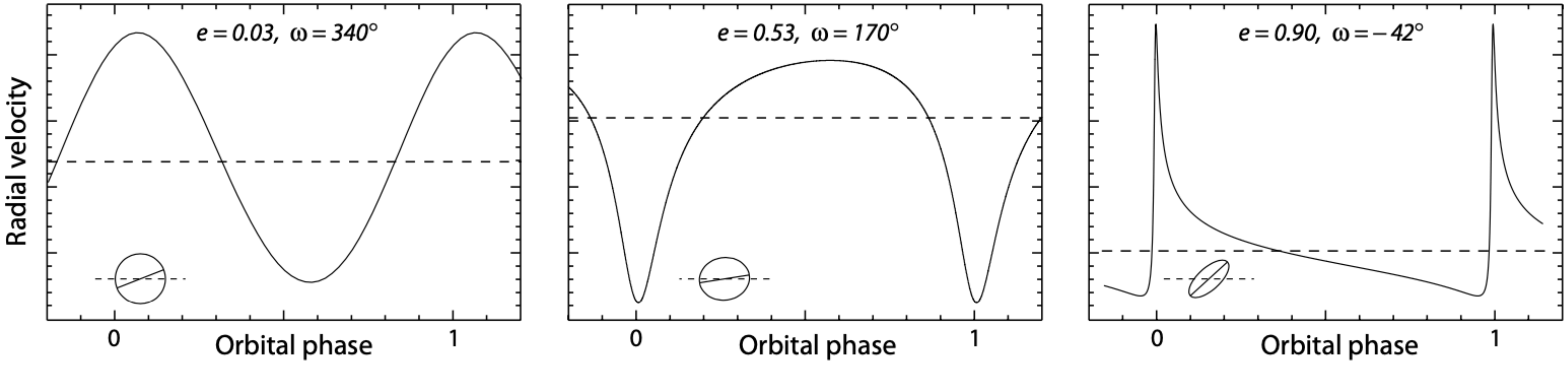
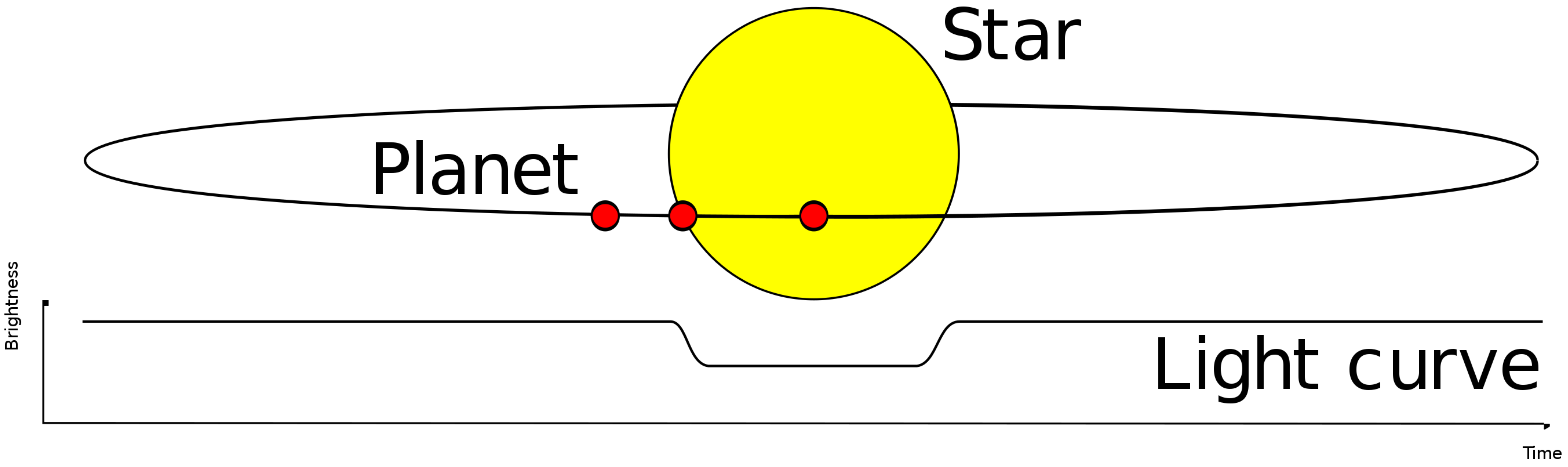


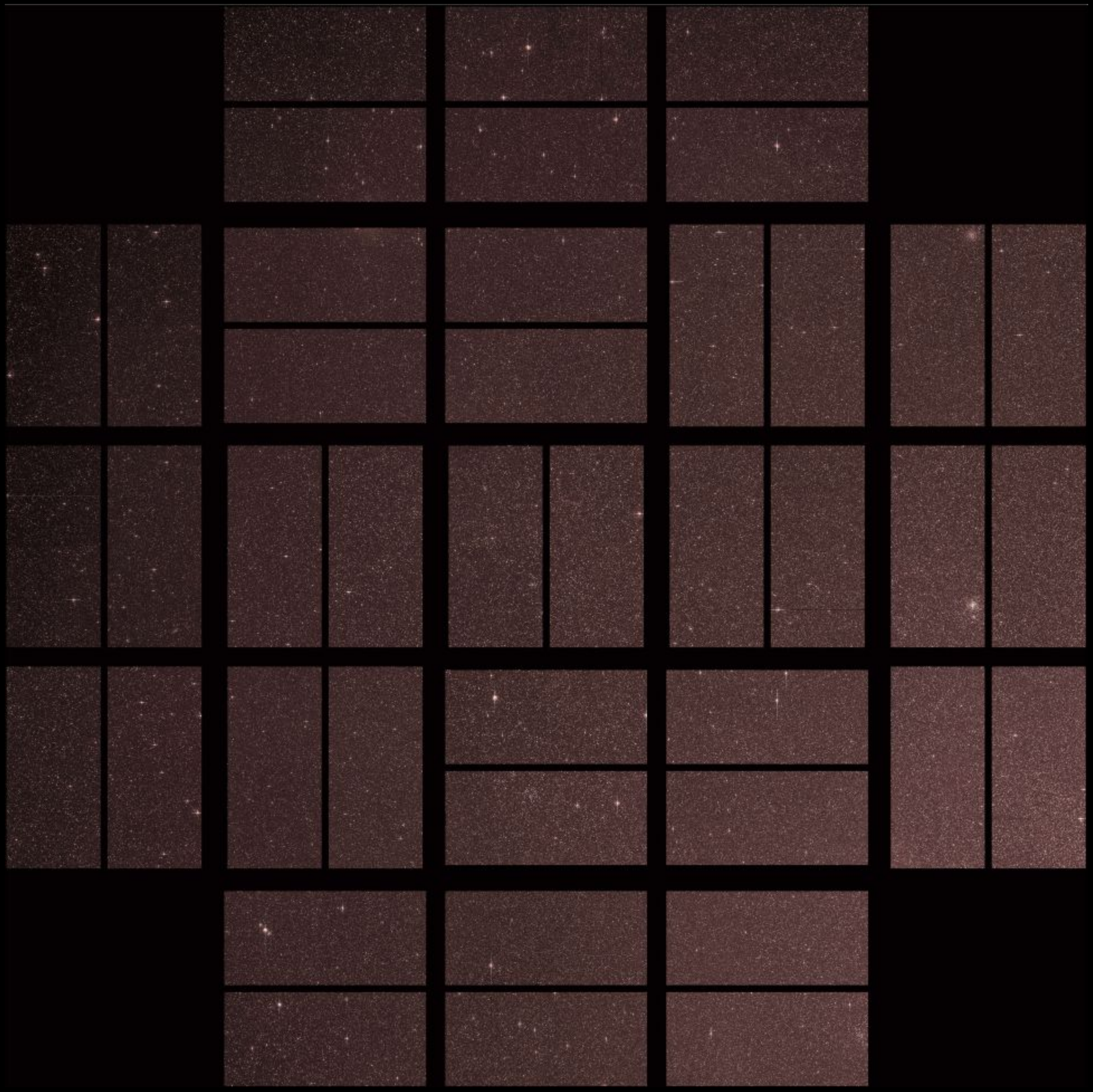
Cumulative Detections Per Year
23 Nov 2021
exoplanetarchive.ipac.caltech.edu
Radial Velocity
Transits
Microlensing
Imaging
Timing Variations
Orbital Brightness
Modulation
Astrometry
Disk Kinematics
Cumulative Number of Detections
0
1000
2000
3000
4000
Discovery Year
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

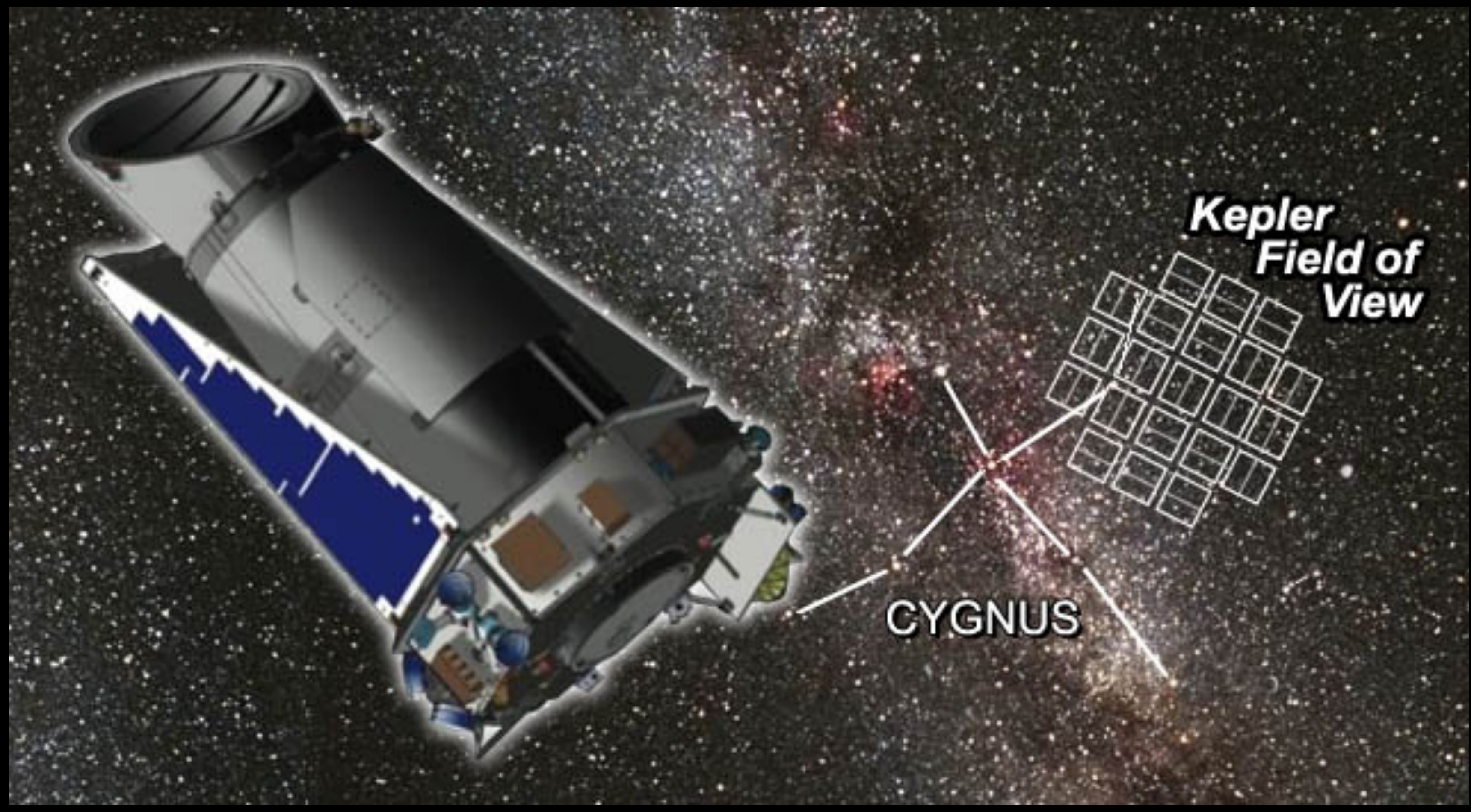
$$P^2 = \frac{4\pi^2}{G(M_1+M_2)} a^3$$

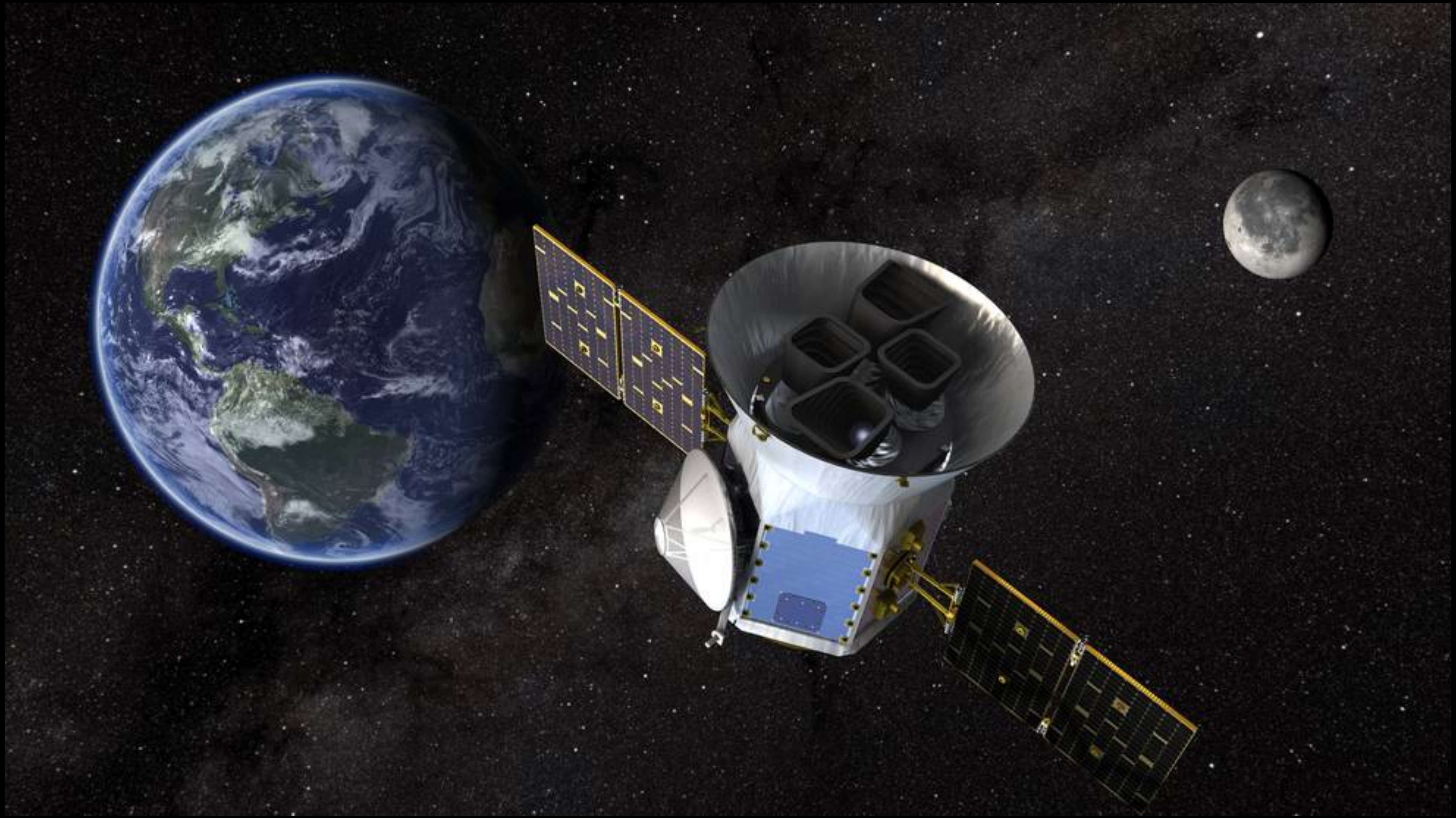


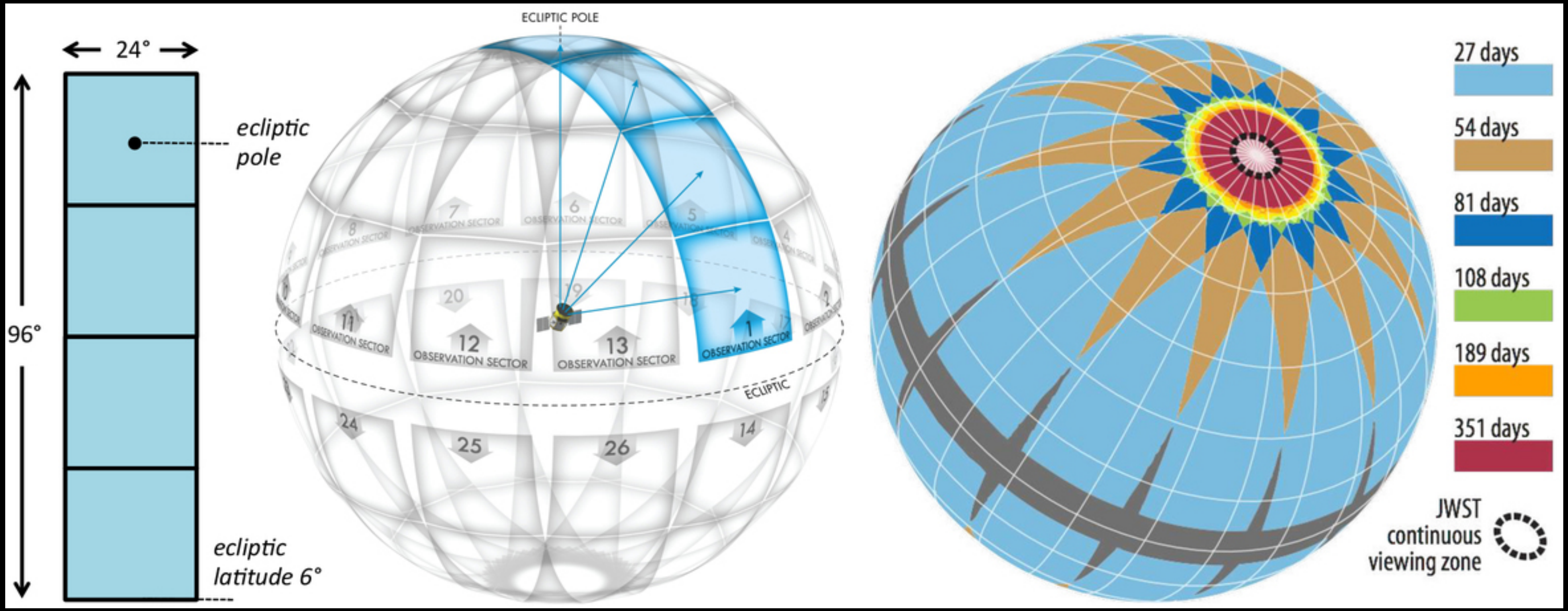


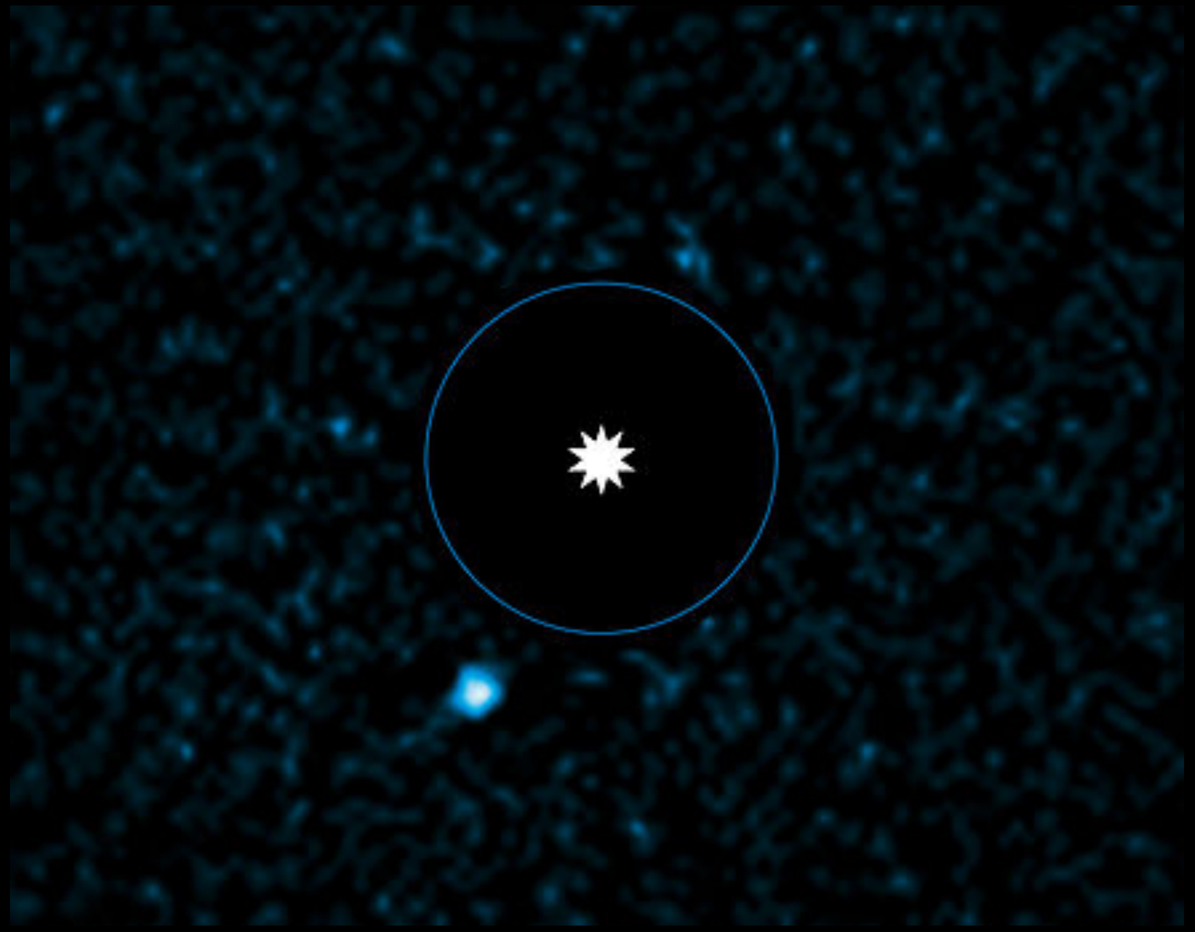

Star
Planet
Brightness
Light curve
Time

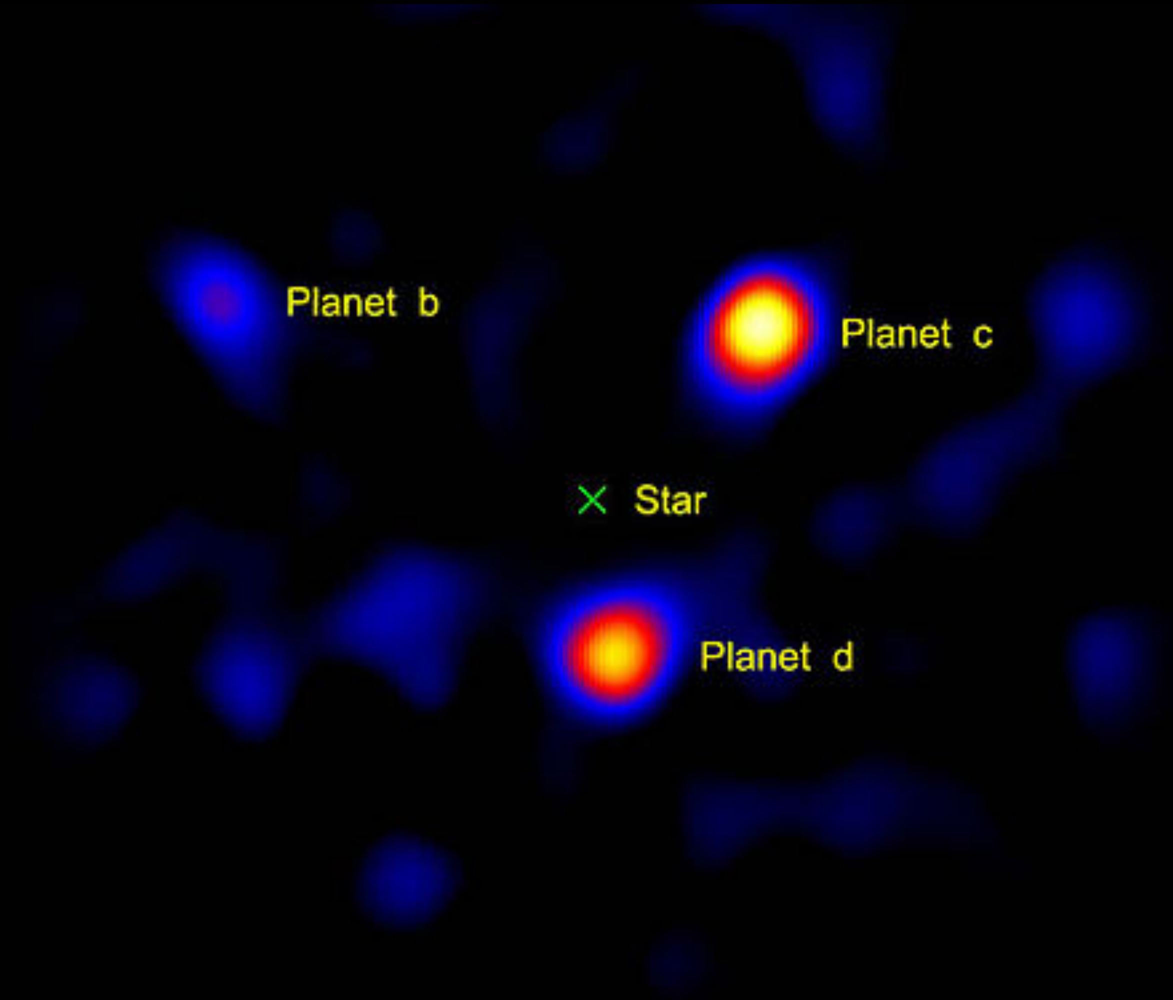


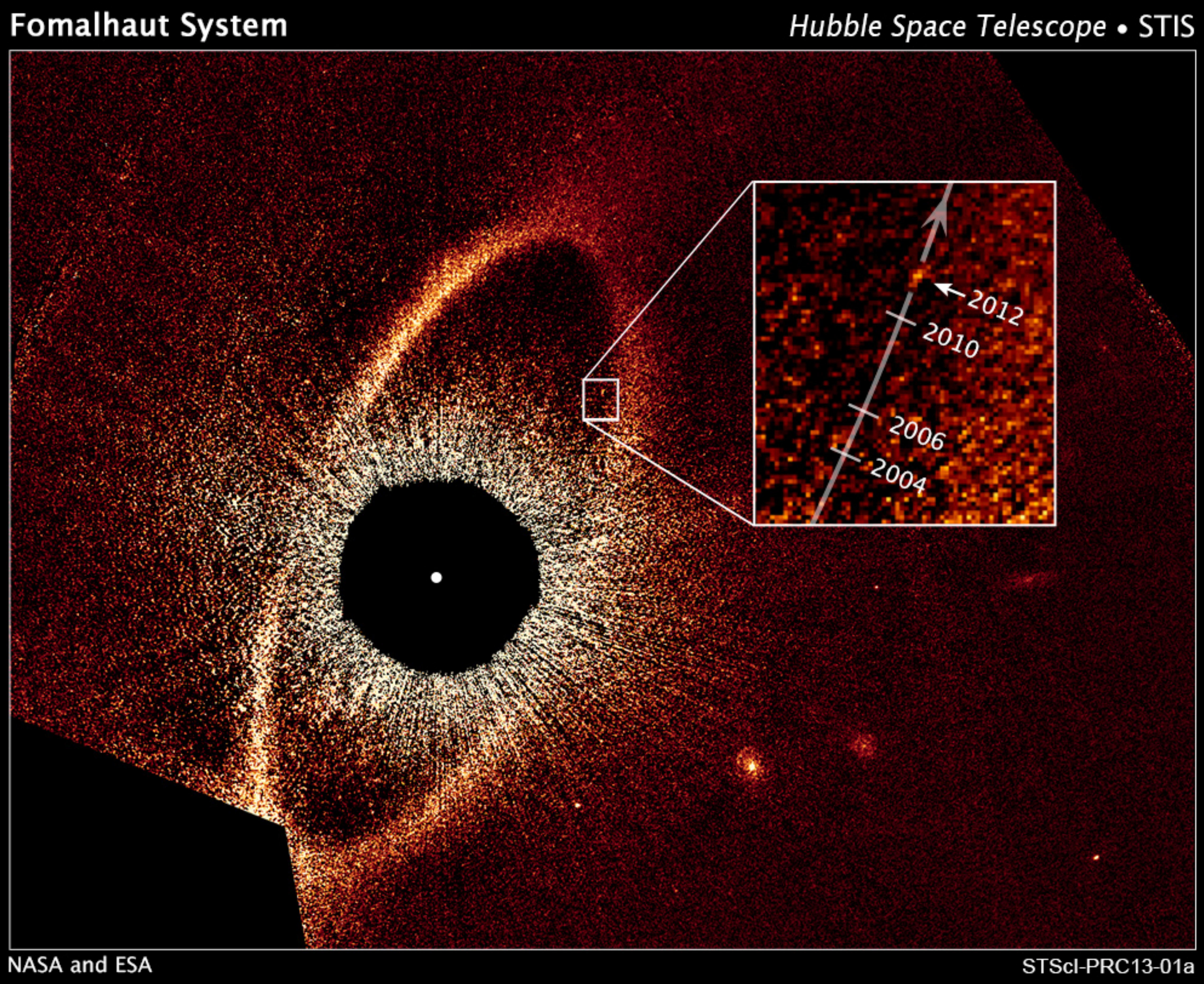

Kepler
Field of
View
CYGNUS

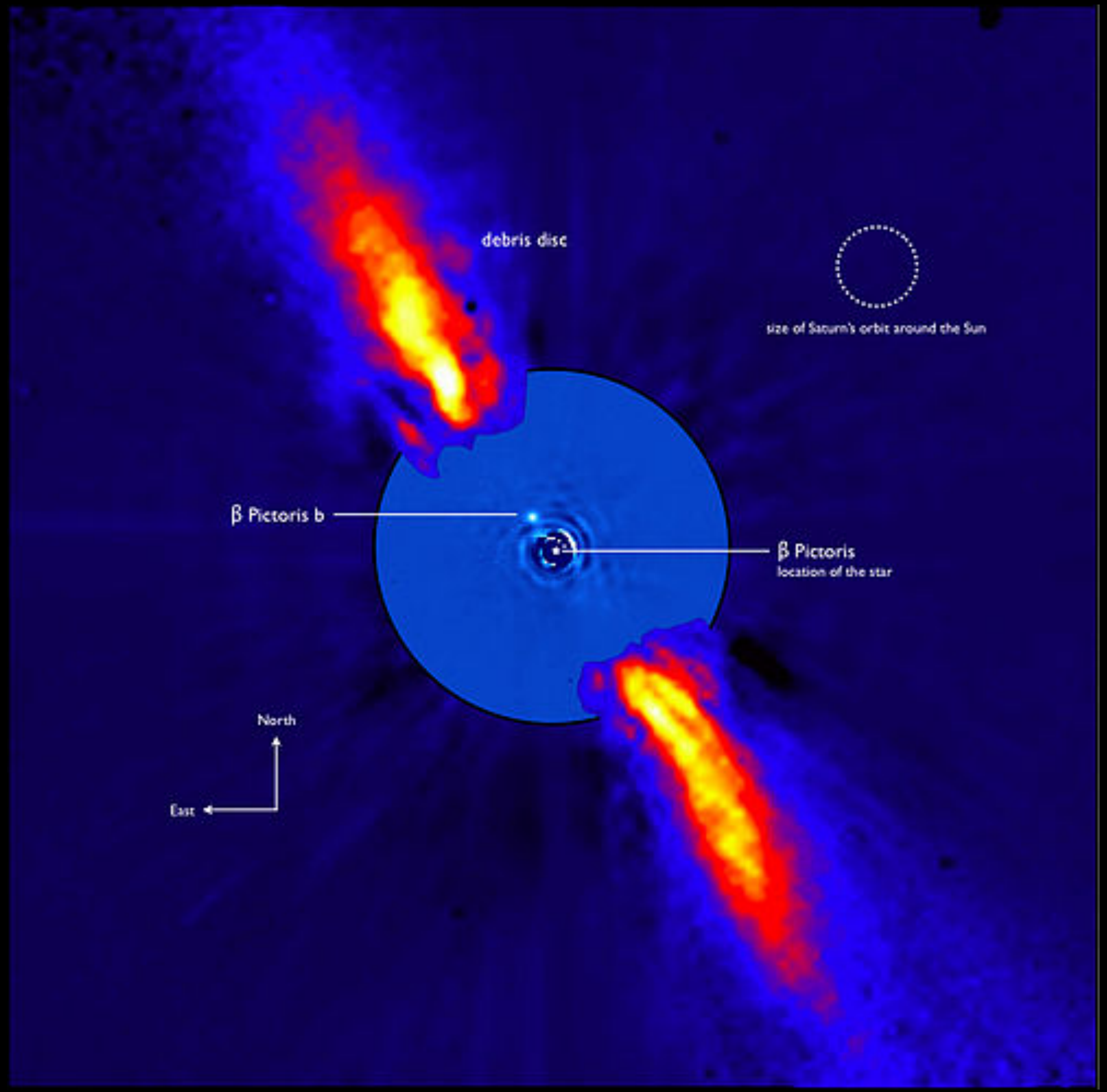


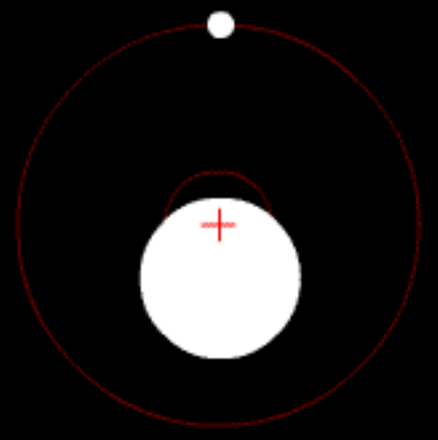

24°
ecliptic pole
96°
ecliptic latitude 6°
ECLIPTIC POLE
11 OBSERVATION SECTOR
12 OBSERVATION SECTOR
13 OBSERVATION SECTOR
1 OBSERVATION SECTOR
20
24
25
26
14
ECLIPTIC
27 days
54 days
81 days
108 days
189 days
351 days
JWST continuous viewing zone

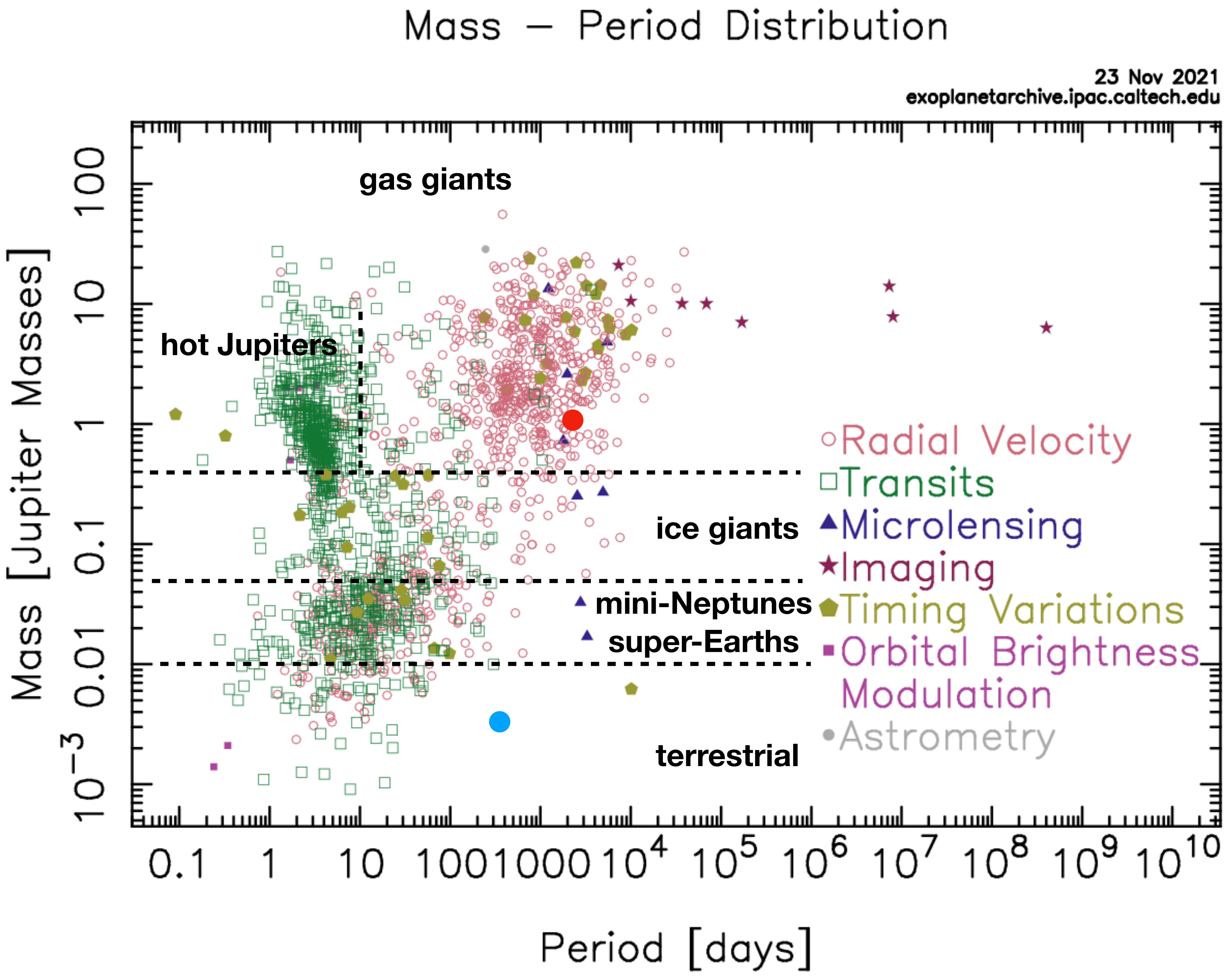



Planet b
Planet c
Star
Planet d


Fomalhaut System
Hubble Space Telescope • STIS
2012
2010
2006
2004
NASA and ESA
STScI-PRC13-01a


debris disc
size of Saturn's orbit around the Sun
β Pictoris b
β Pictoris
location of the star
North
East

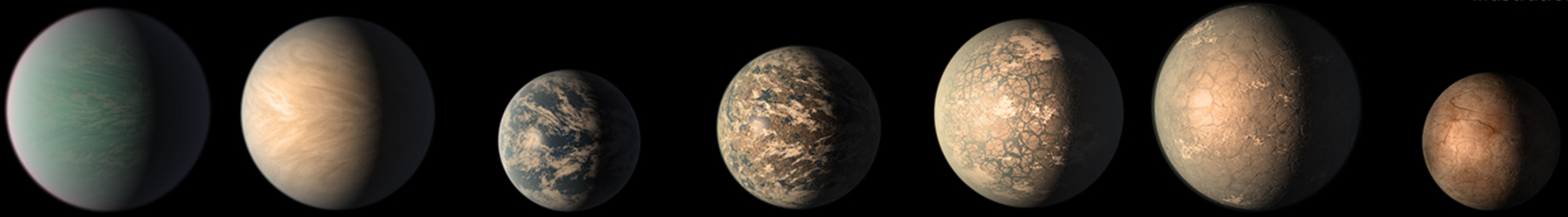




how can we explain this distribution?

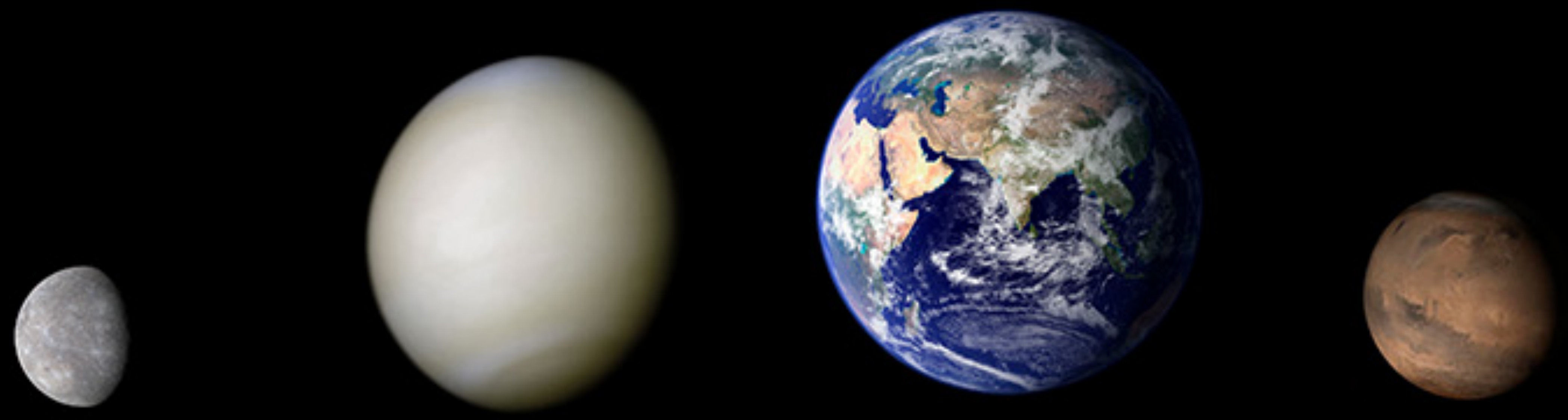
Illustrations

TRAPPIST-1 System
Feb. 2018



	b	c	d	e	f	g	h
Orbital Period	1.51 *days*	2.42 *days*	4.05 *days*	6.10 *days*	9.21 *days*	12.36 *days*	18.76 *days*
Distance to Star	0.0115 *AU*	0.0158 *AU*	0.0223 *AU*	0.0293 *AU*	0.0385 *AU*	0.0469 *AU*	0.0619 *AU*
Planet Radius	1.12 R_{earth}	1.10 R_{earth}	0.78 R_{earth}	0.91 R_{earth}	1.05 R_{earth}	1.15 R_{earth}	0.77 R_{earth}
Planet Mass	1.02 M_{earth}	1.16 M_{earth}	0.30 M_{earth}	0.77 M_{earth}	0.93 M_{earth}	1.15 M_{earth}	0.33 M_{earth}
Planet Density	0.73 ρ_{earth}	0.88 ρ_{earth}	0.62 ρ_{earth}	1.02 ρ_{earth}	0.82 ρ_{earth}	0.76 ρ_{earth}	0.72 ρ_{earth}
Surface Gravity	0.81 *g*	0.96 *g*	0.48 *g*	0.93 *g*	0.85 *g*	0.87 *g*	0.55 *g*

Solar System
Rocky Planets



	Mercury	Venus	Earth	Mars
Orbital Period	87.97 *days*	224.70 *days*	365.26 *days*	686.98 *days*

R **= star formation rate in our galaxy**

number of new stars formed per year

f_p = fraction of stars with planets around them

n_e = number of habitable planets per star system

f_ℓ = fraction of habitable planets that develop life

f_i = fraction of living planets that develop intelligent life

f_c = fraction of intelligent species that develop technology capable of communicating across space (e.g. radio)

* This implies a willingness to make the effort to use technology to communicate. We've been broadcasting I Love Lucy for decades, but the signal will quickly fade thanks to the inverse square law. Even if another species can detect this broadcast from many light-years away, would this constitute a recognizable attempt at intelligent communication?

L **= number of years ("lifetime") a civilization spends in the technological broadcast phase**

N = number of communicating civilizations

$$R \times f_p \times n_e \times f_\ell \times f_i \times f_c \times L$$