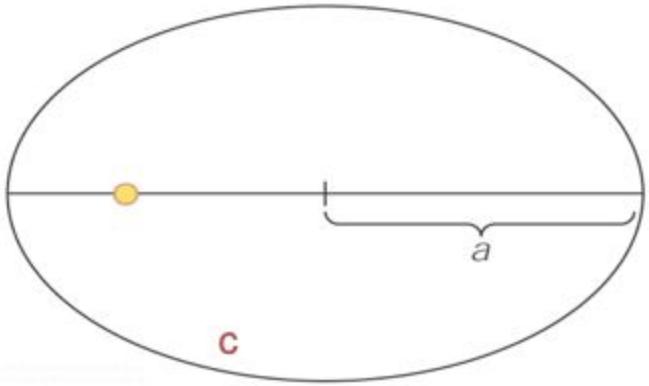
ASTR367

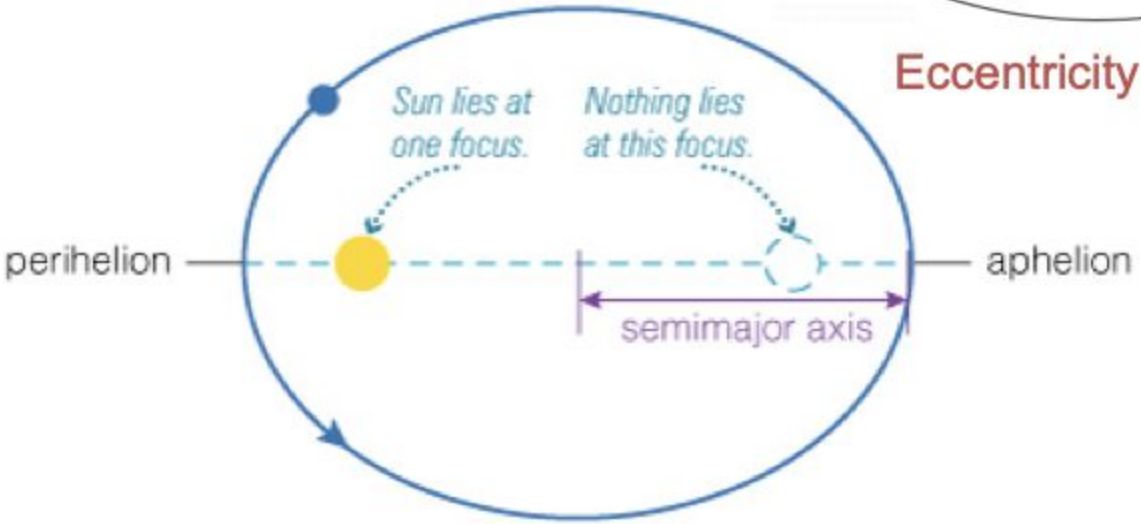
Binaries

Kepler's 1st Law

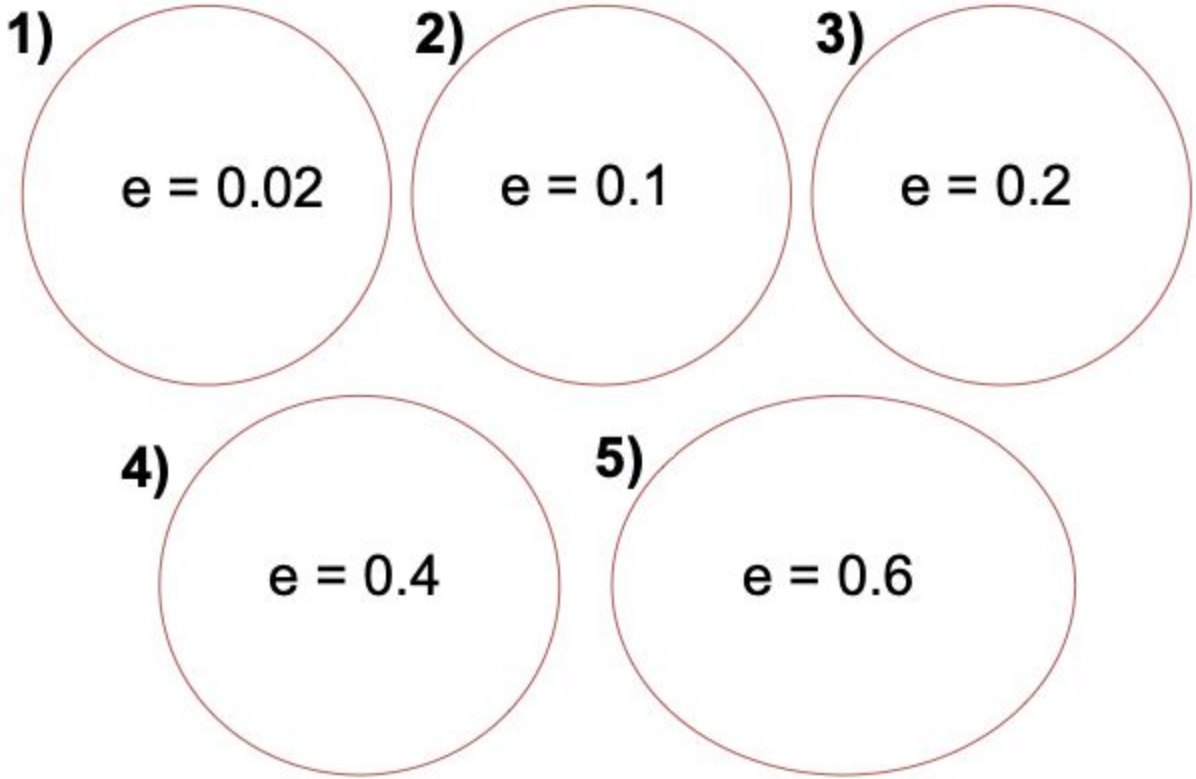
Law #1: The orbits of the planets are **ellipses** with the Sun at one focus.



Eccentricity e = c/a

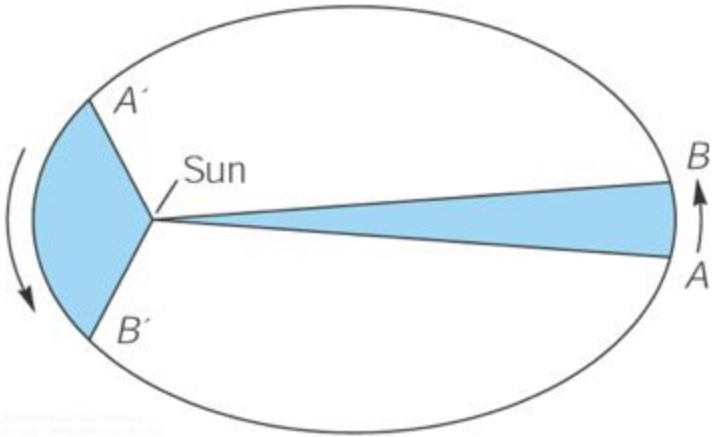


Eccentricities of Ellipses



Kepler's 2nd Law

Law #2: A line from a planet to the sun sweeps over equal areas in equal intervals of time.



Kepler's 3rd Law

A planet's orbital period (P) squared is proportional to its average distance from the sun (a) cubed:

Closer orbits go faster

$$P_y^2 = a_{AU}^3$$

(P_y = period in years;
a_{AU} = distance in AU)

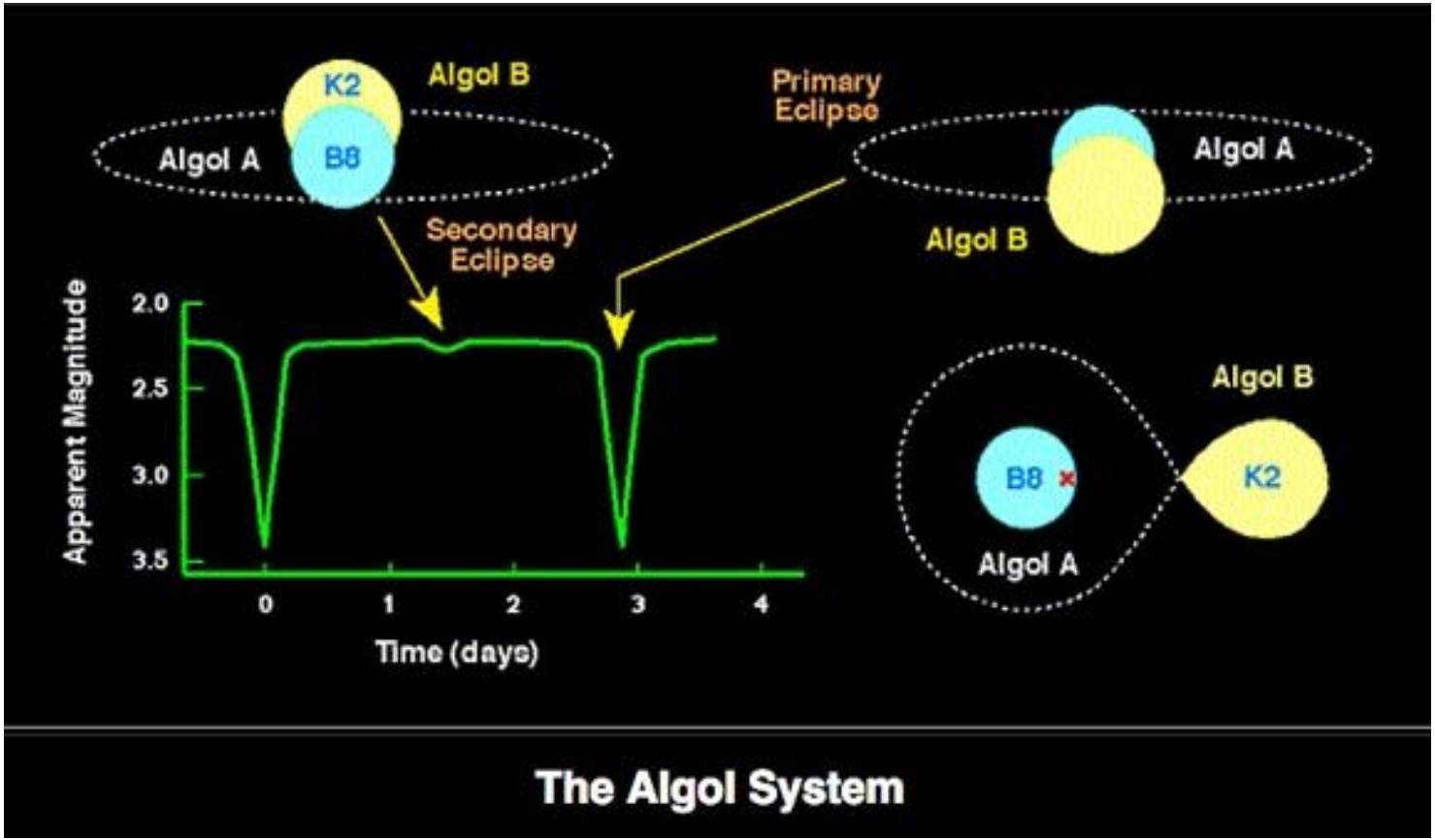
http://www.solarsystemscope.com/

http://astro.unl.edu/naap/pos/animations/kepler.html

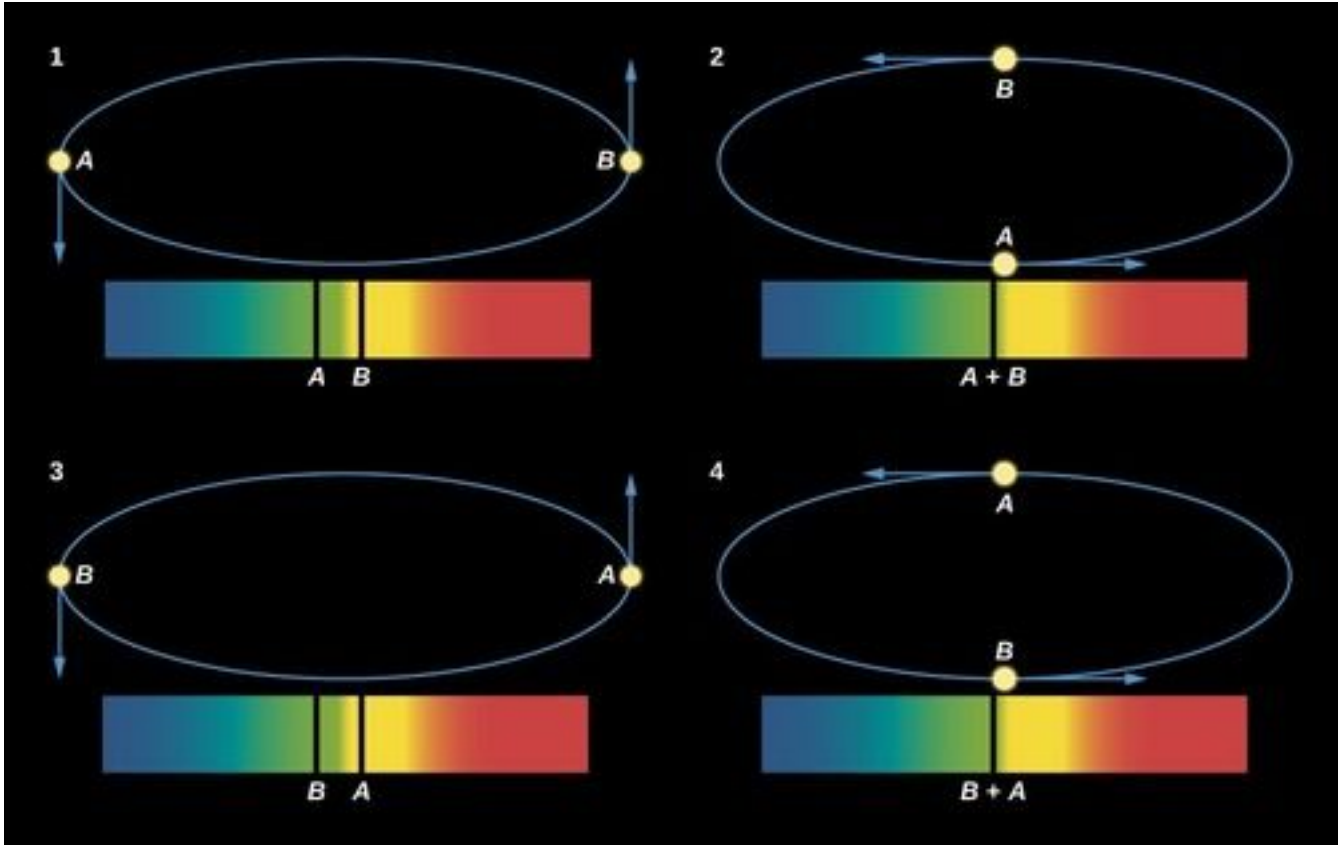
Optical doubles

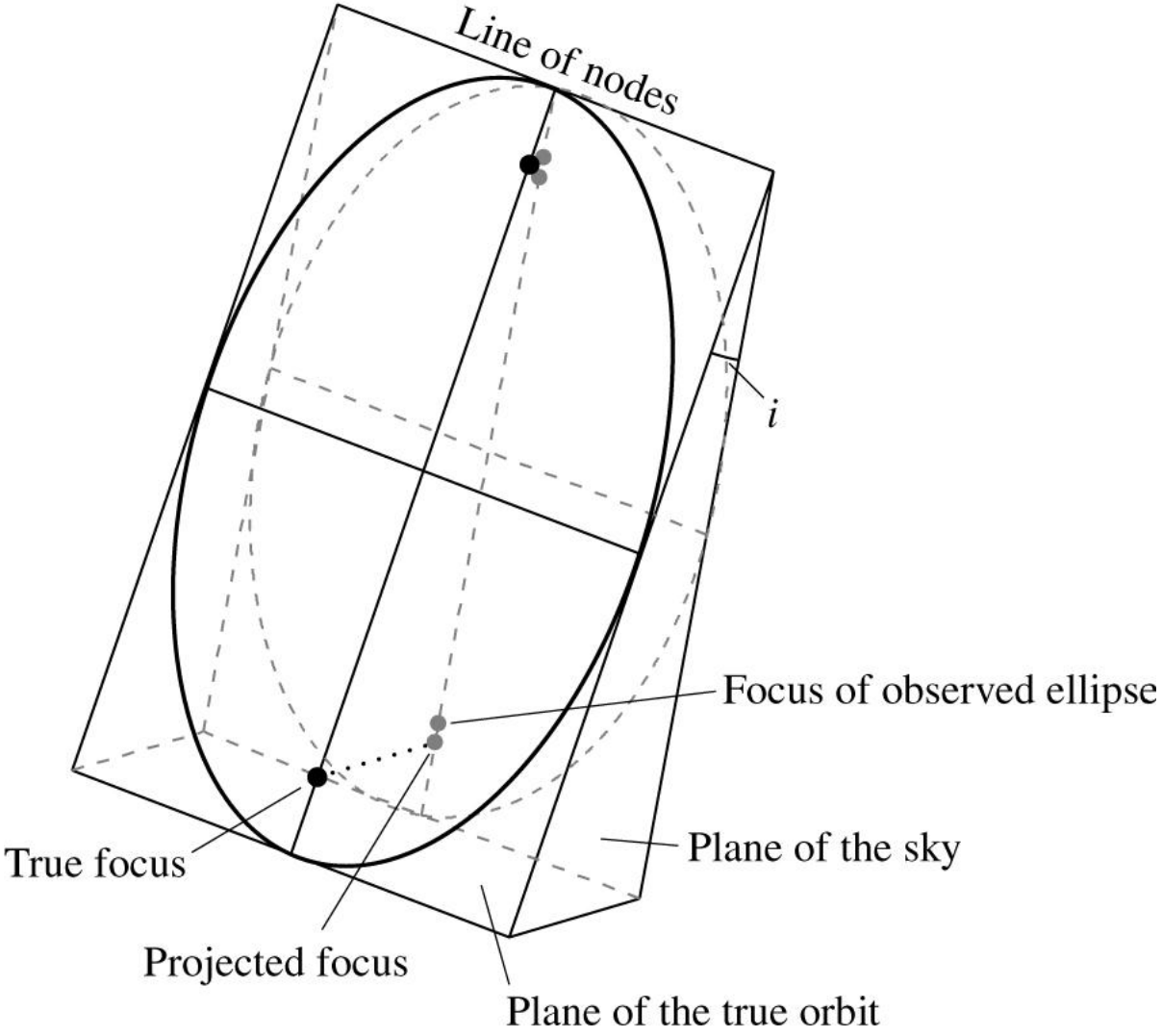
Visual Binaries

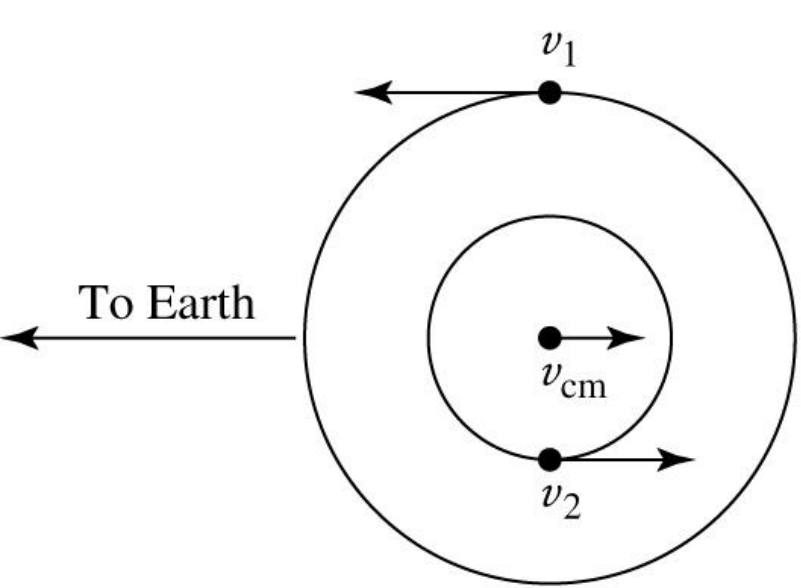
Eclipsing binary



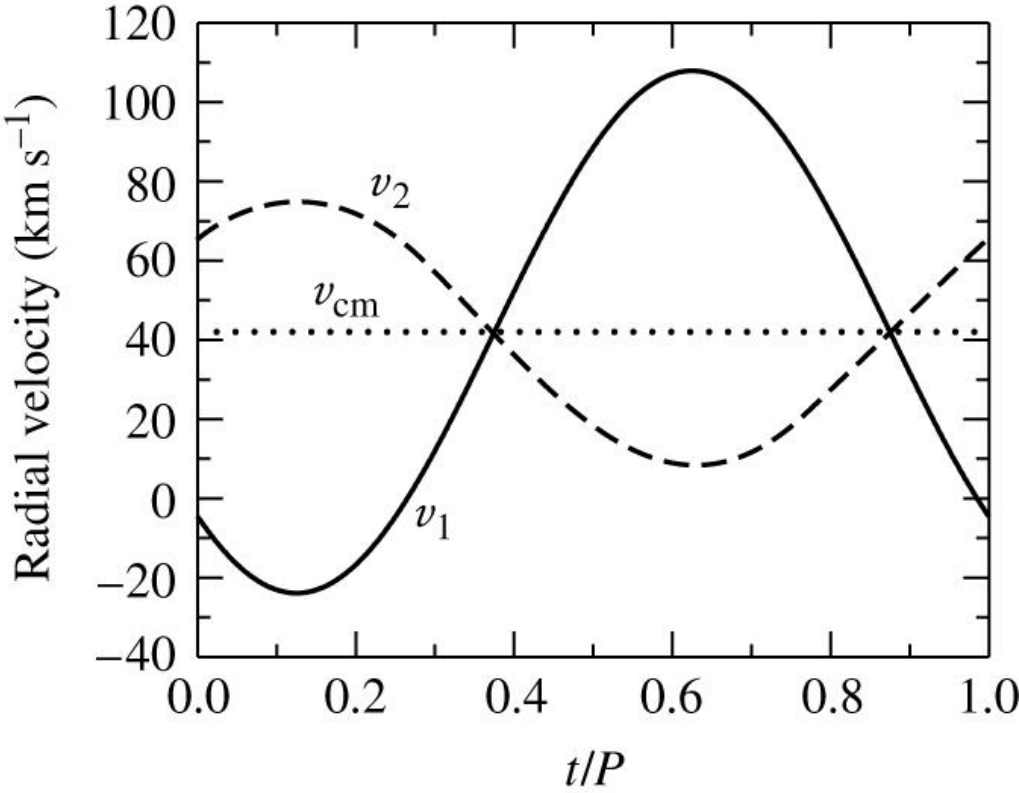
Spectrum Binaries



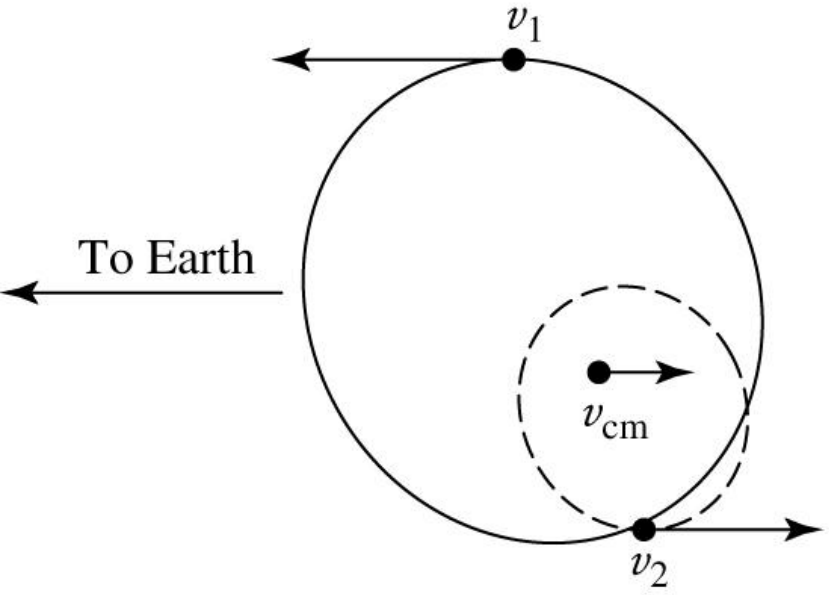

Line of nodes
i
Focus of observed ellipse
Plane of the sky
True focus
Projected focus
Plane of the true orbit


v_1
To Earth
v_{cm}
v_2

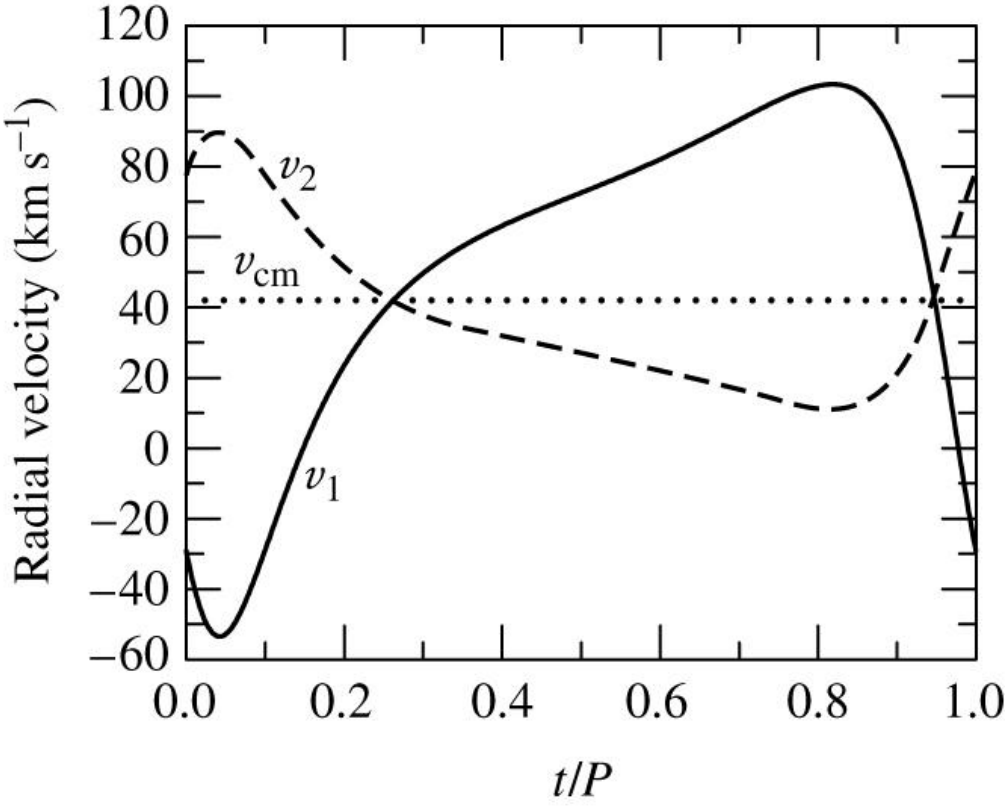
(a)


120
100
80
60
40
20
0
−20
−40
Radial velocity (km s^{-1})
v_2
v_{cm}
v_1
0.0
0.2
0.4
0.6
0.8
1.0
t/P

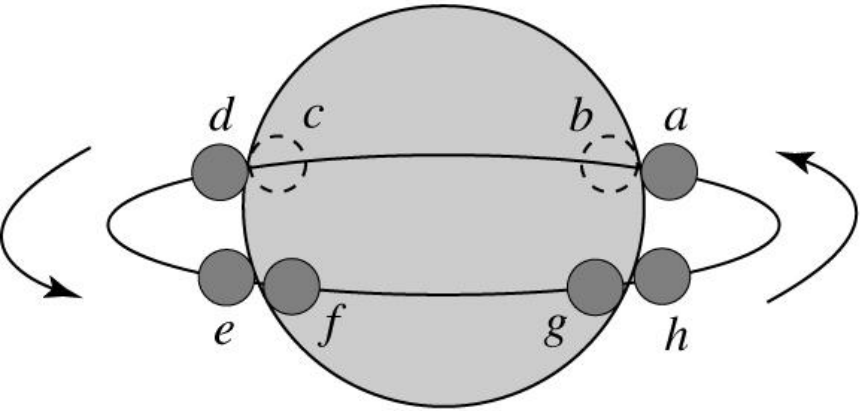
(b)

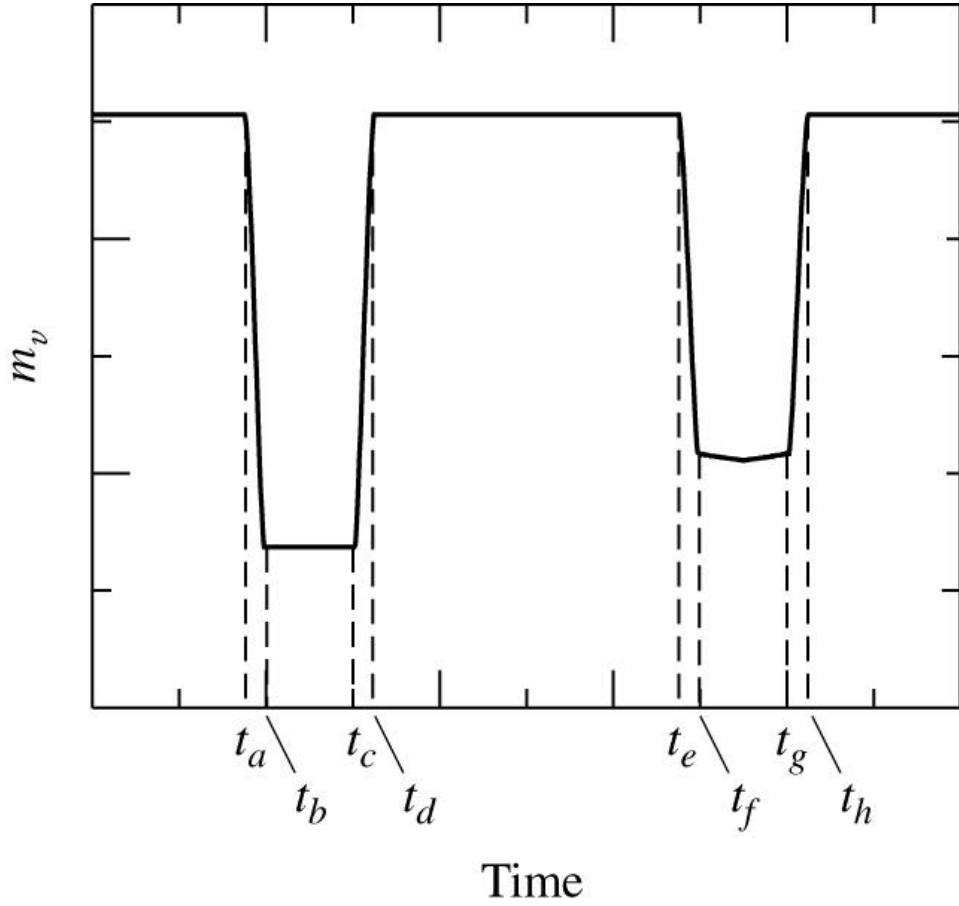

v_1
To Earth
v_{cm}
v_2

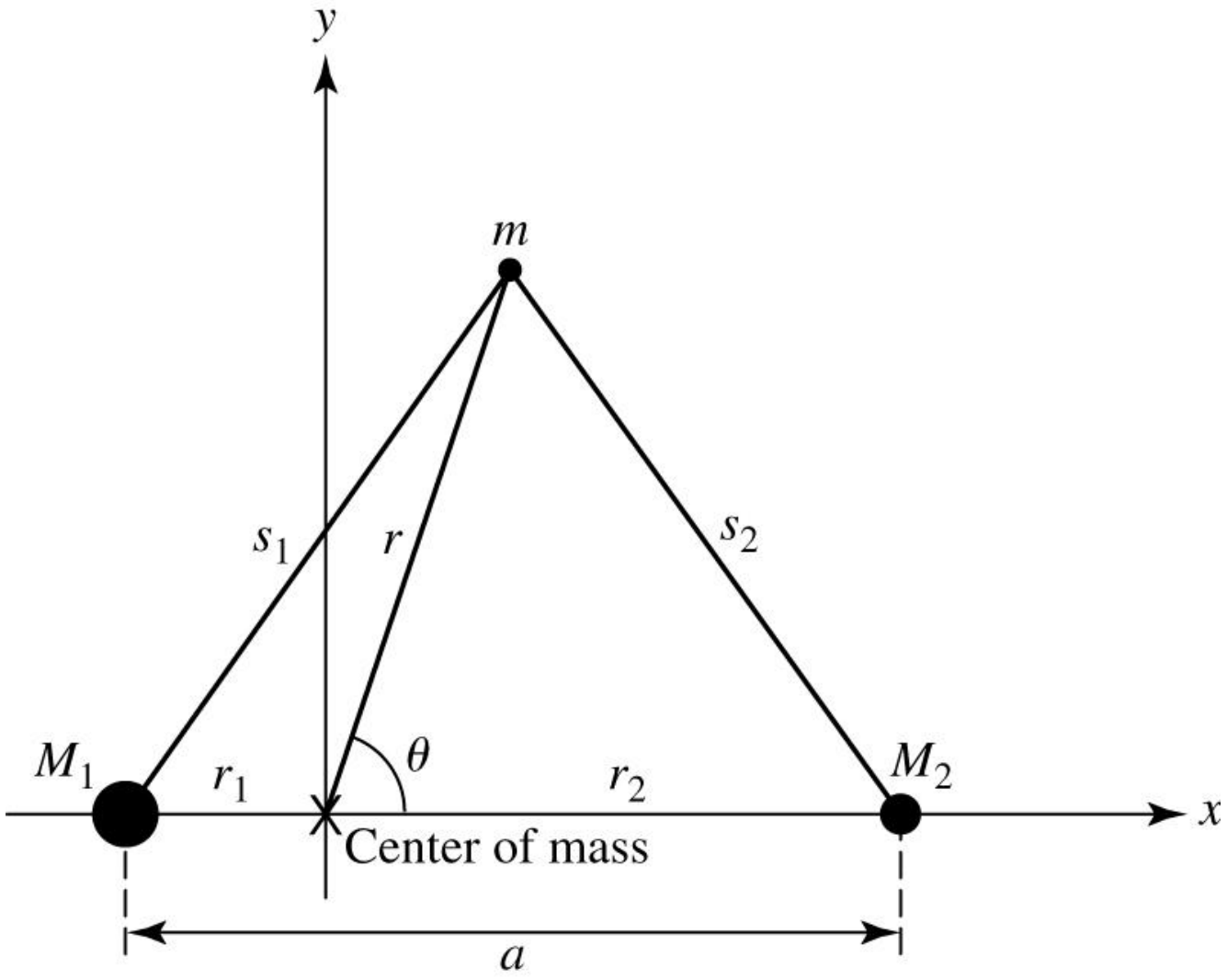
(a)

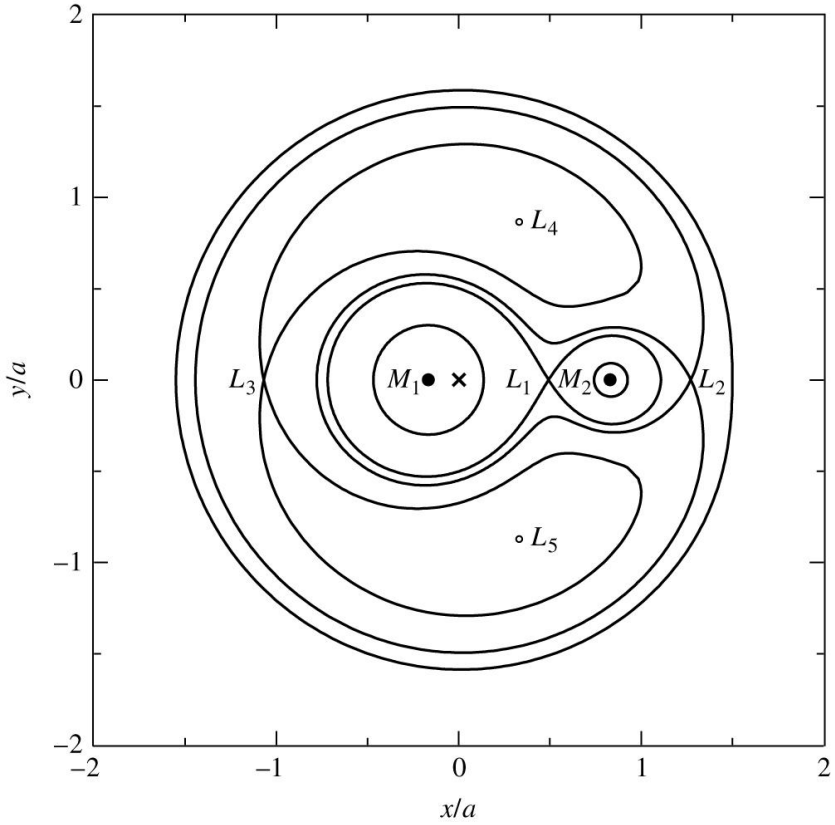

120
100
80
60
40
20
0
−20
−40
−60
Radial velocity (km s^{-1})
v_2
v_{cm}
v_1
0.0
0.2
0.4
0.6
0.8
1.0
t/P

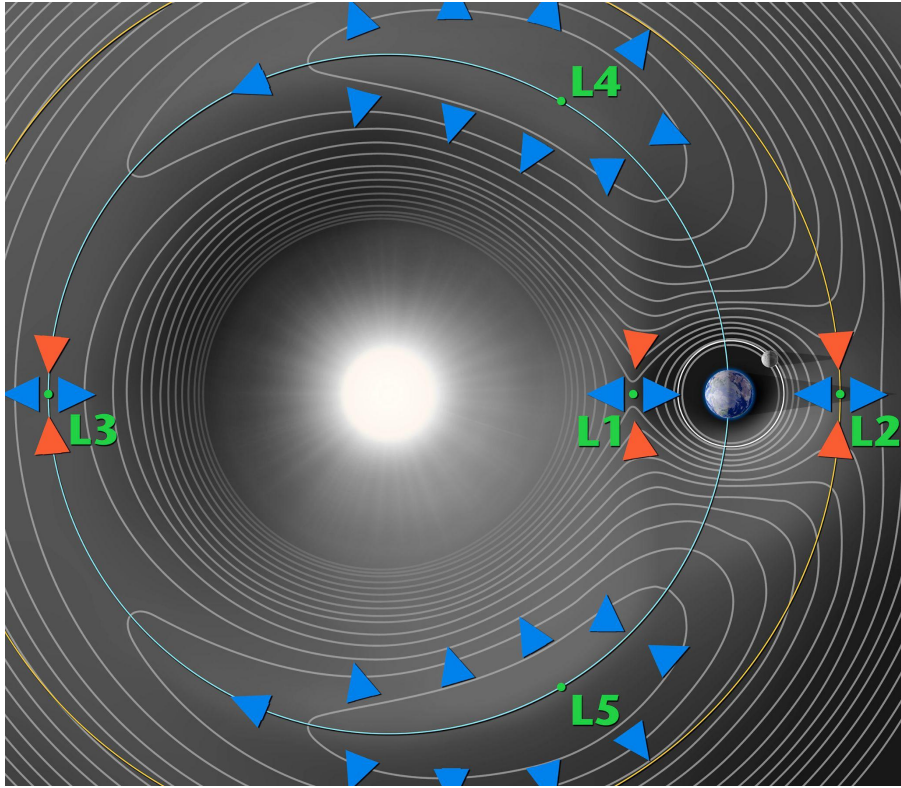
(b)

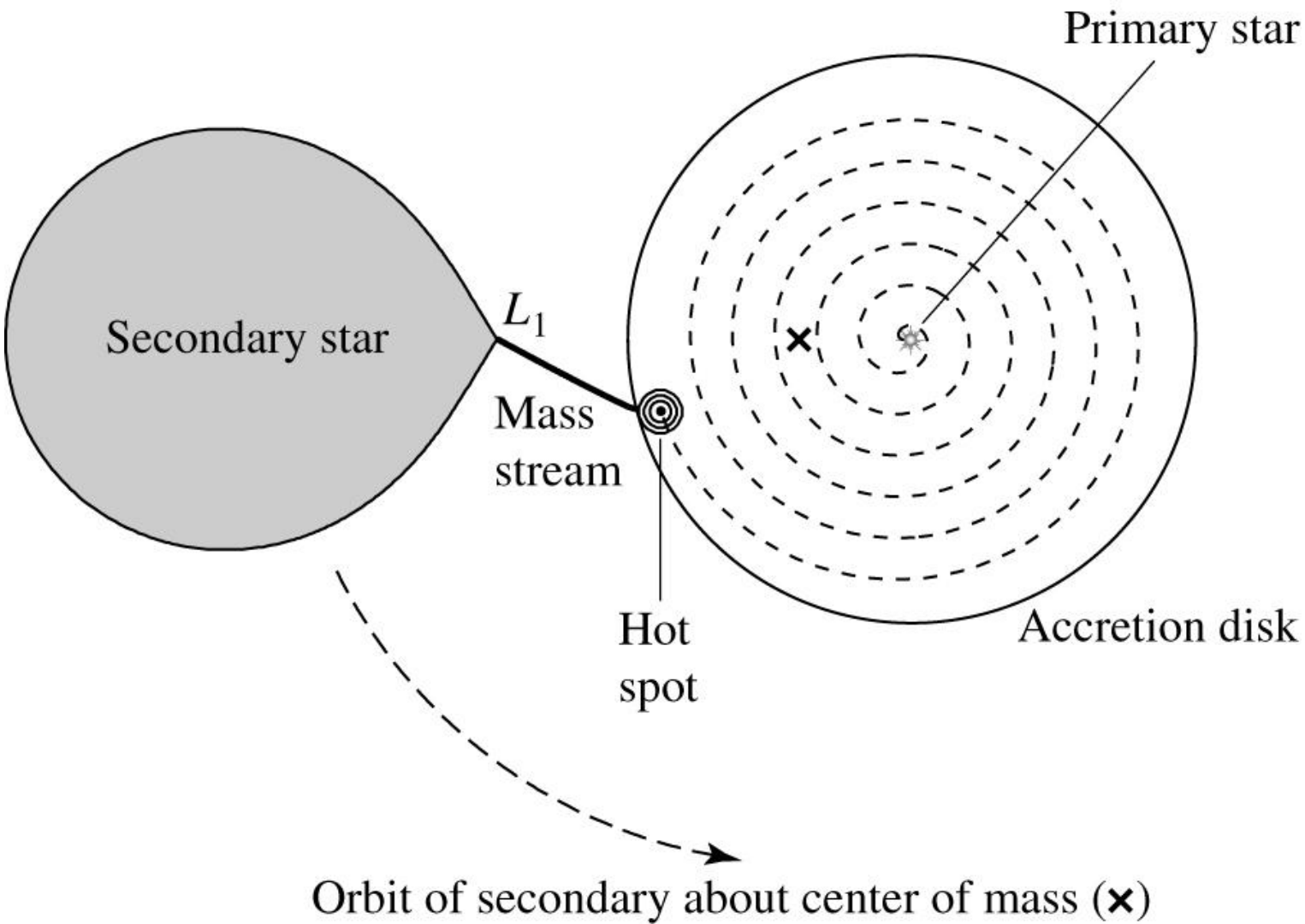

d
c
b
a
e
f
g
h

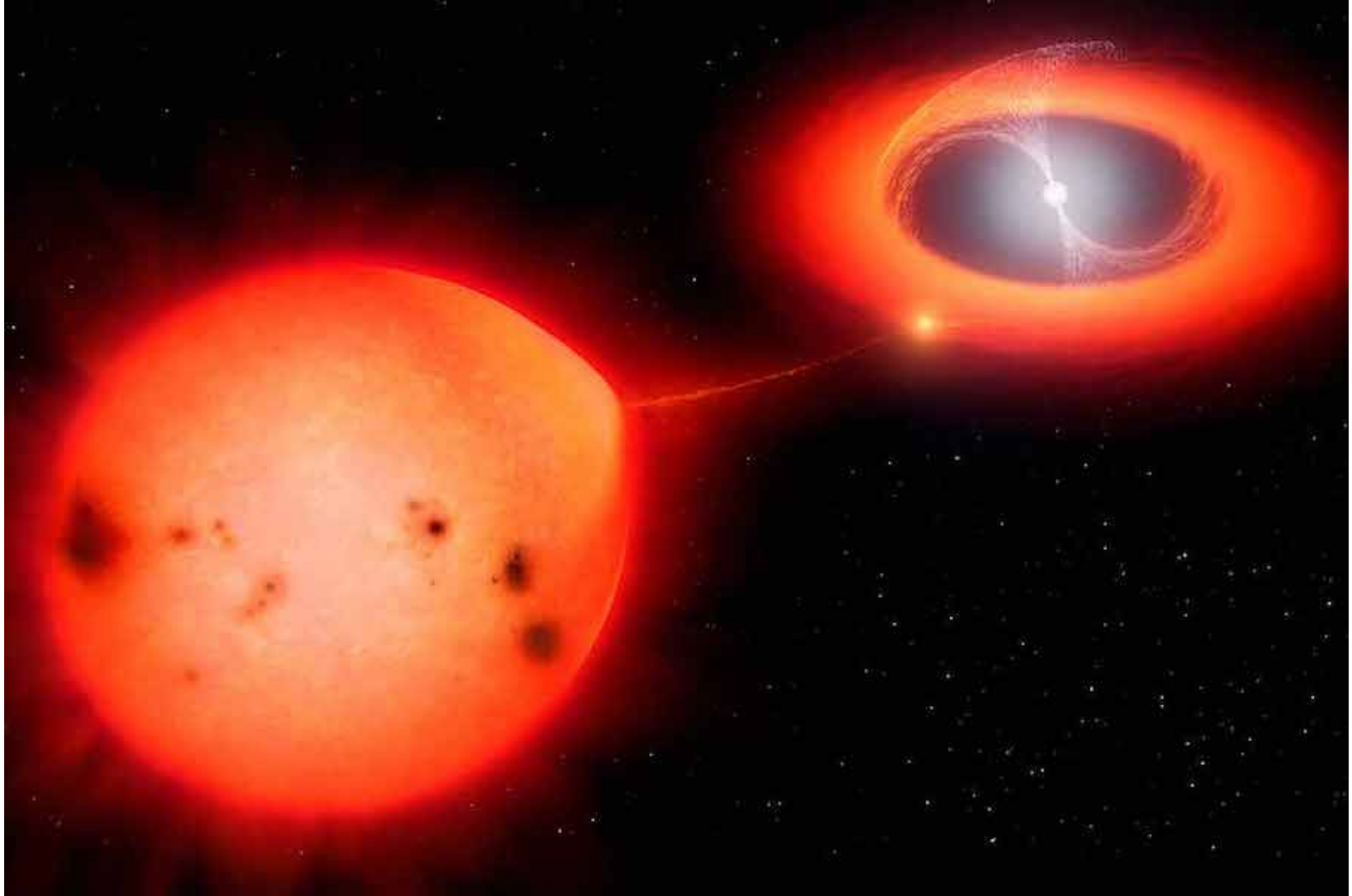

m_v
t_a
t_b
t_c
t_d
t_e
t_f
t_g
t_h
Time

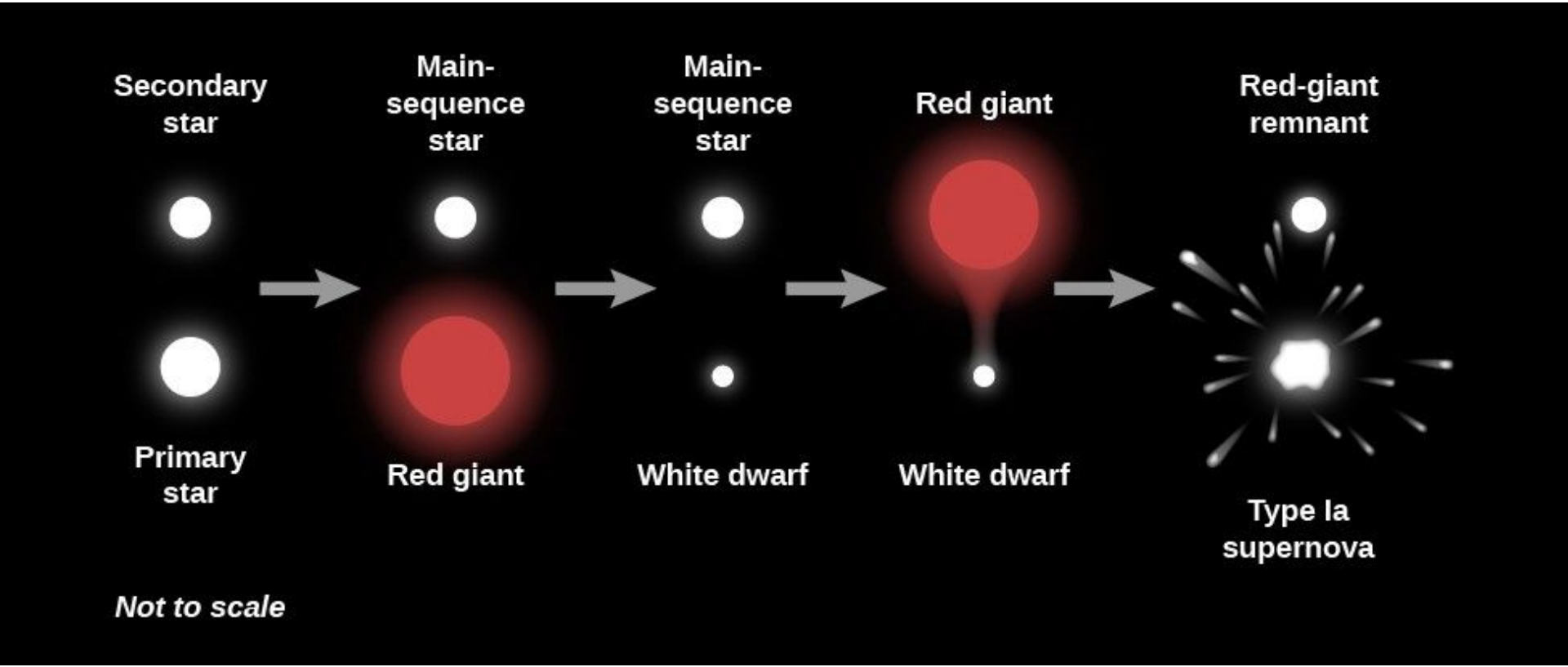

y
m
s_1
r
s_2
M_1
r_1
θ
r_2
M_2
x
Center of mass
a

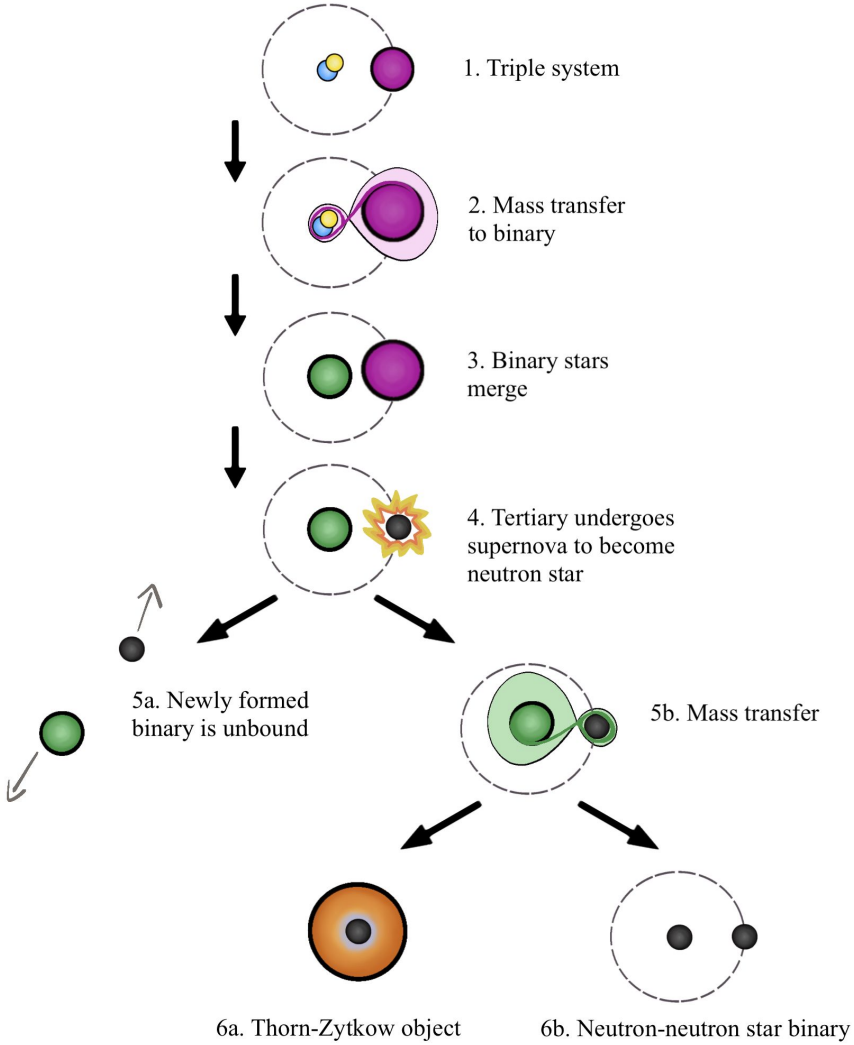

2
1
0
−1
−2
−2
−1
0
1
2
y/a
x/a
L_4
L_5
L_3
M_1
L_1
M_2
L_2


L4
L3
L1
L2
L5


Primary star
Secondary star
L_1
Mass
stream
Hot
spot
Accretion disk
Orbit of secondary about center of mass (×)




Secondary star
Main-sequence star
Main-sequence star
Red giant
Red-giant remnant
Primary star
Red giant
White dwarf
White dwarf
Type Ia supernova
Not to scale


1. Triple system
2. Mass transfer to binary
3. Binary stars merge
4. Tertiary undergoes supernova to become neutron star
5a. Newly formed binary is unbound
5b. Mass transfer
6a. Thorn-Zytkow object
6b. Neutron-neutron star binary