Trip to Mars
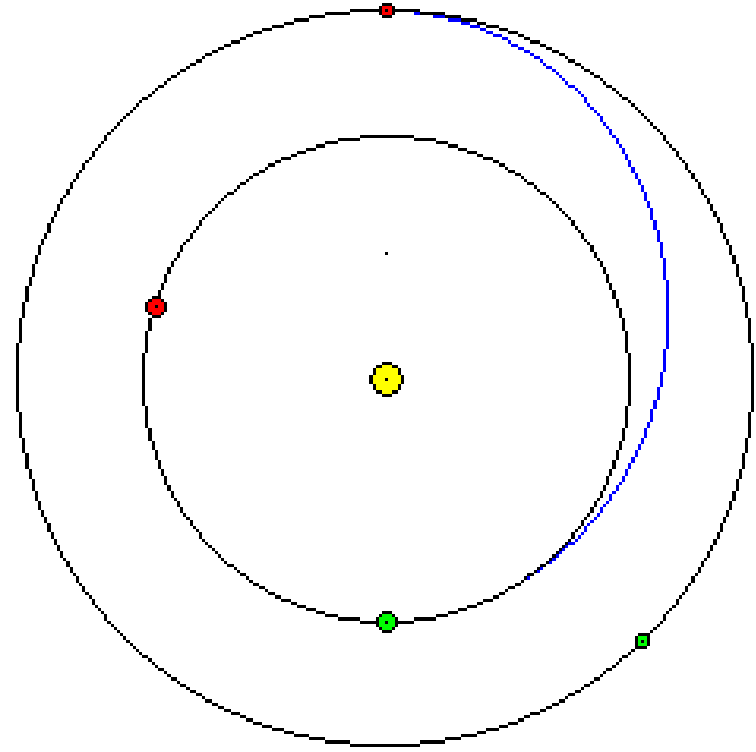## (and beyond!)

Grace Jung
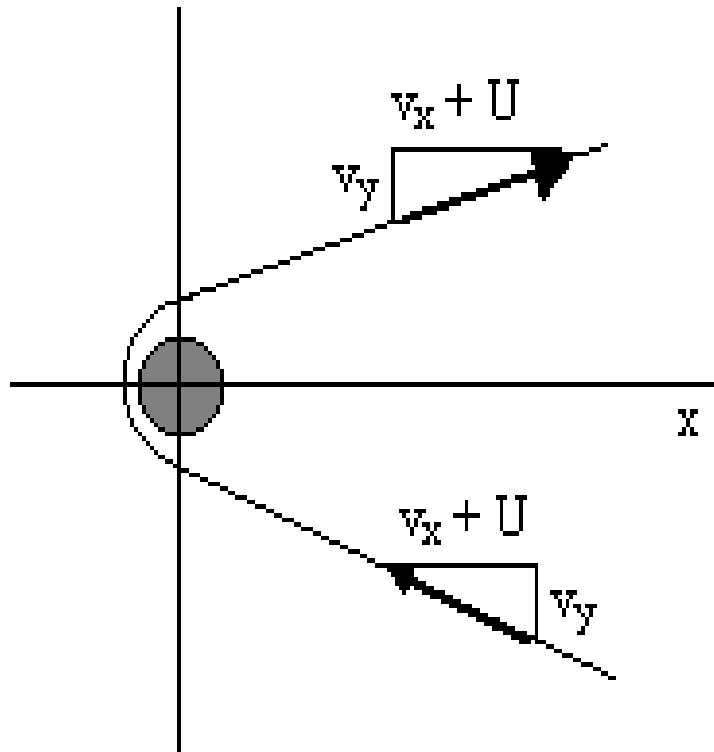05/10/2012

Hohmann Transfer Orbit
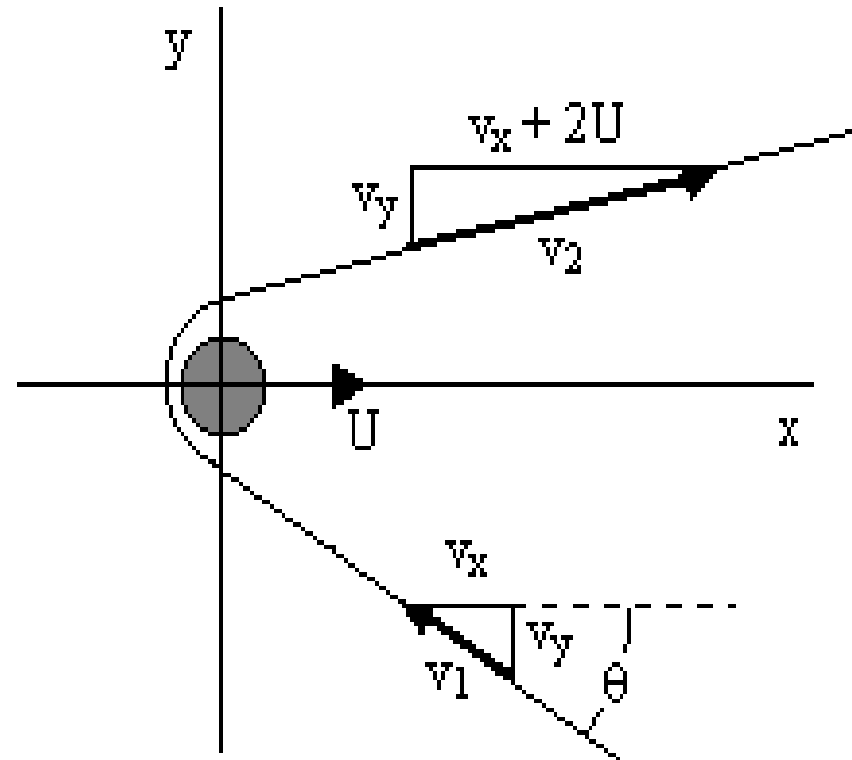
- Efficient way to travel between two orbits

http://members.shaw.ca/quadibloc/science/spa02.htm

Slingshot Method

Planet's Rest Frame

Solar Reference Frame

- Conservation of energy

http://www.mathpages.com/home/kmath114/kmath114.htm

Problem

- To model a voyage from Earth to Mars

- Calculate position and velocity of rocket and planets

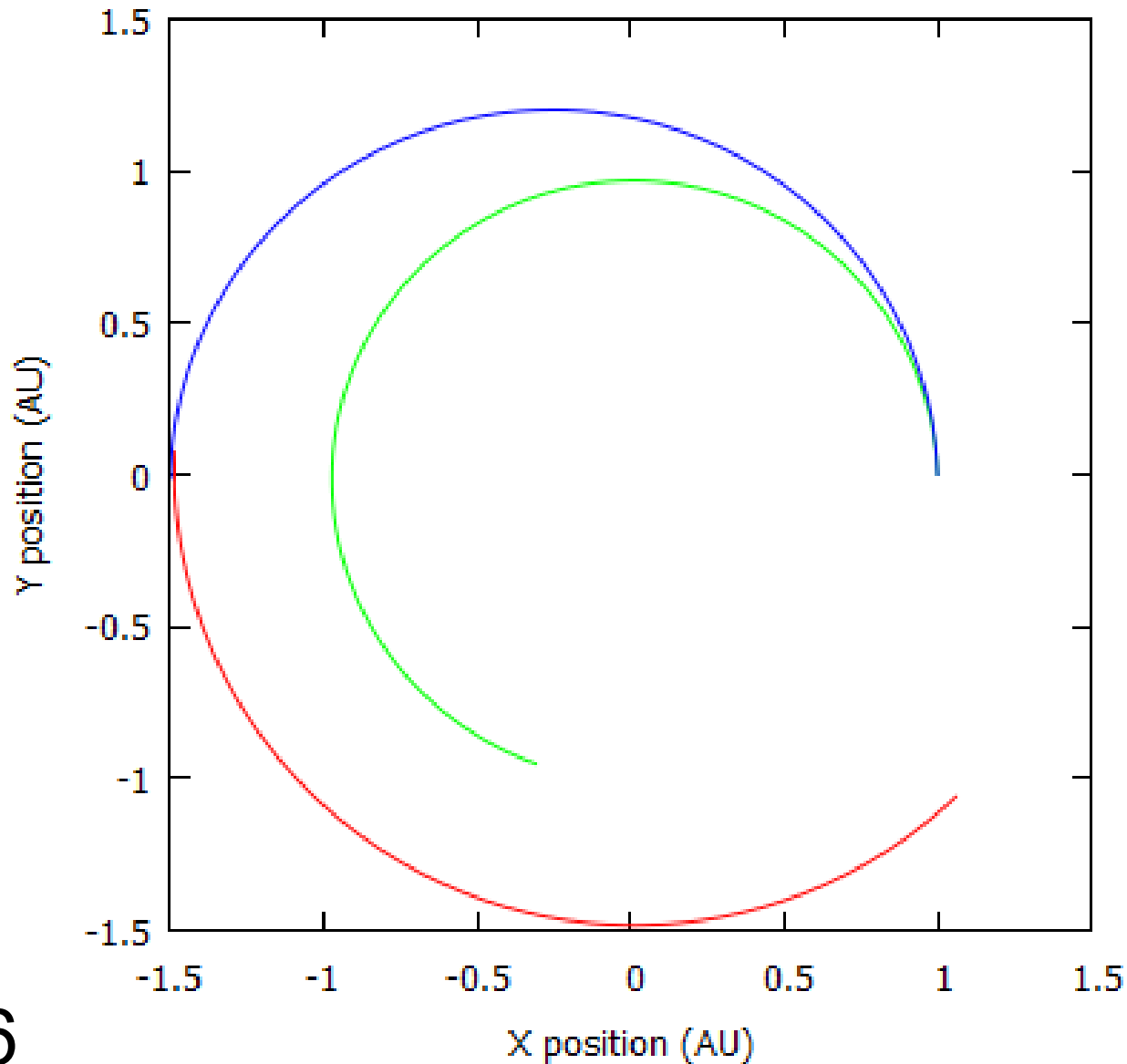- Determine the 'best' method of travel:
  time and fuel efficiency

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Solution

- Use Runge Kutta 4 to solve ODEs for position and velocity of bodies

$$\mathbf{F}_{12} = -\frac{Gm_1 m_2}{r_{12}^3} \mathbf{r}_{12}$$

$$\frac{d\mathbf{r}}{dt} = \mathbf{v}$$
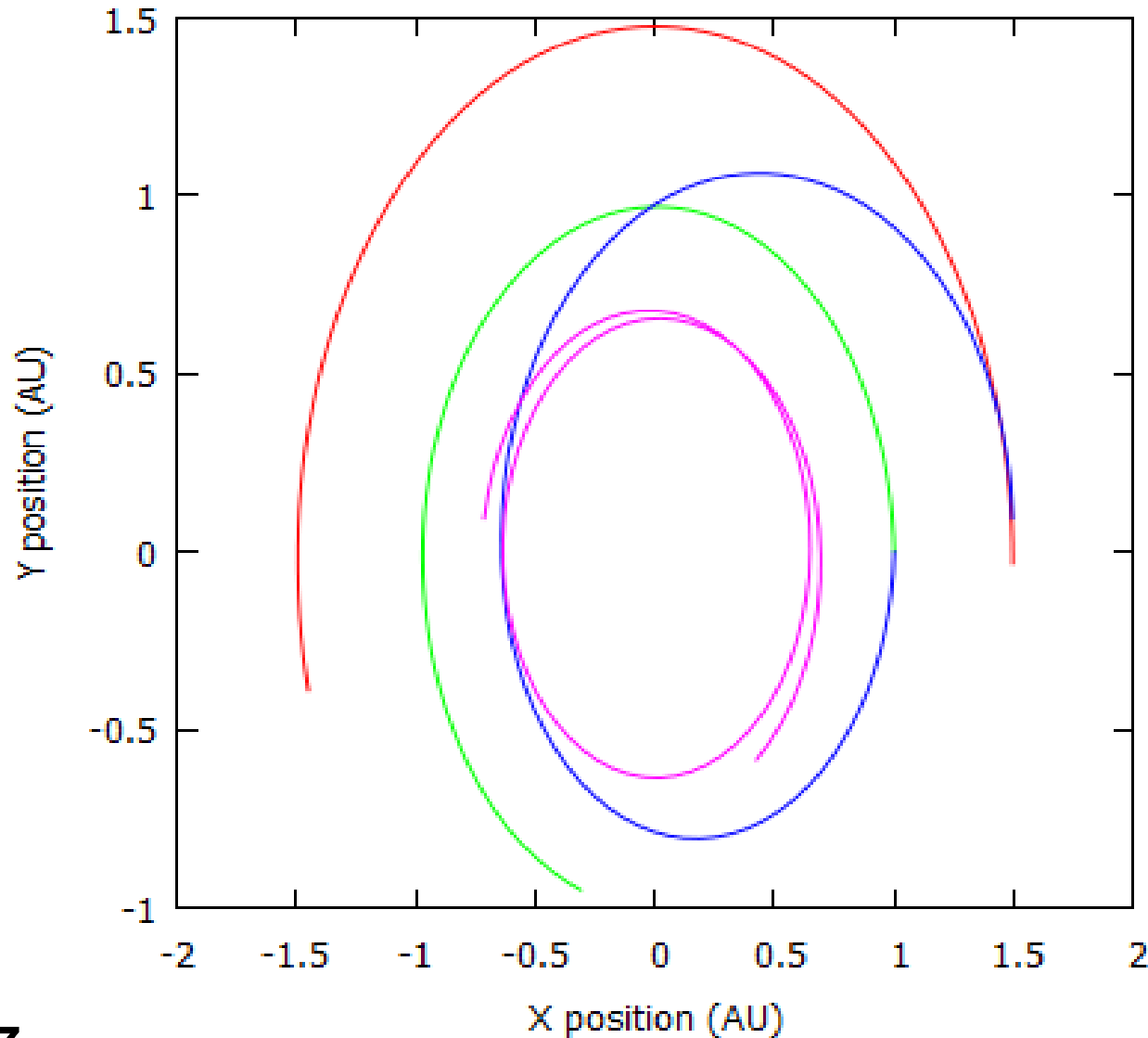
$$\frac{d\mathbf{v}}{dt} = -\frac{GM}{r^3} \mathbf{r}$$

G=Gravitational constant, m=mass, r=position, v= velocity
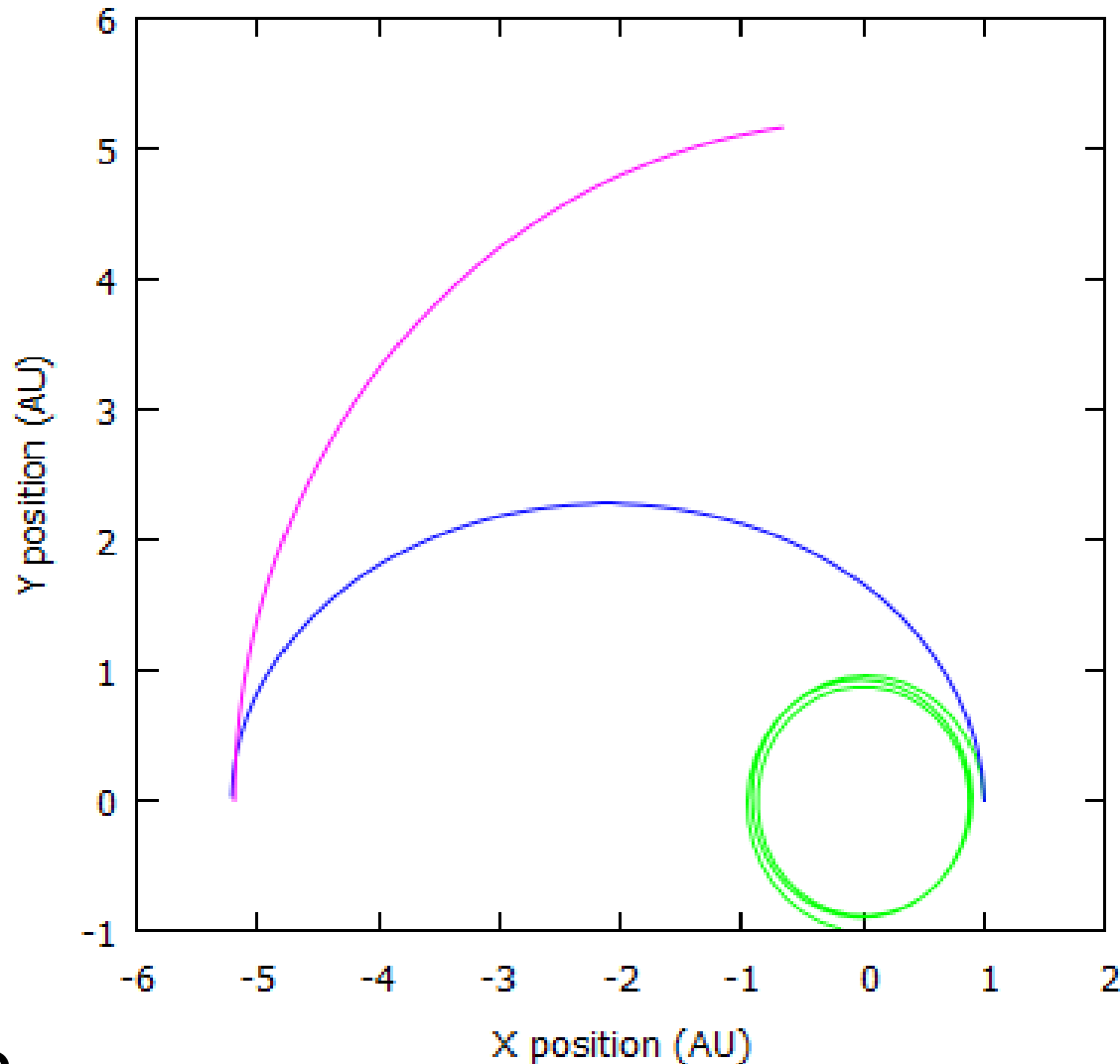
Hohmann Orbit to Mars

- Mars
  Earth
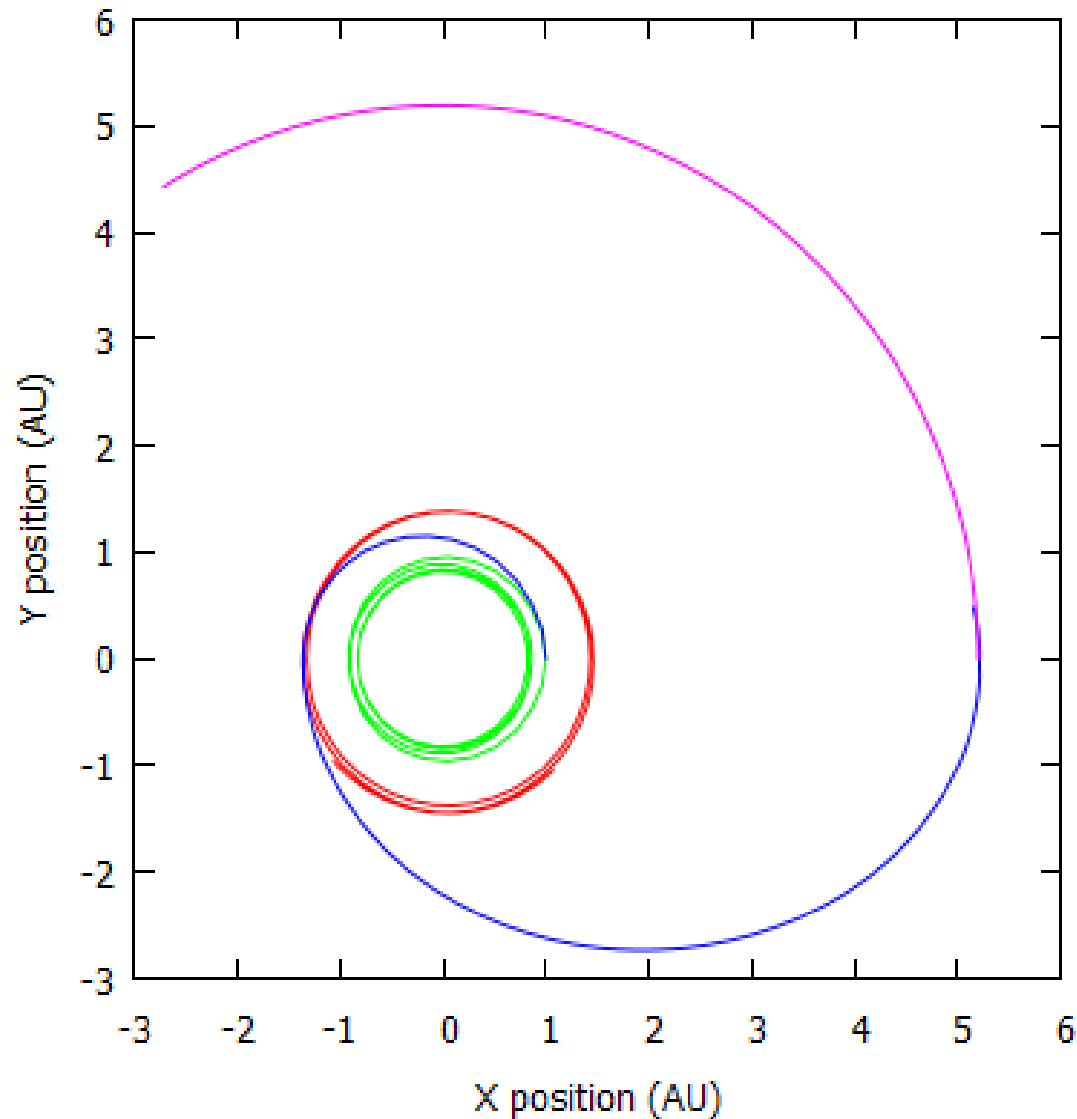 Rocket

- Total time:
  0.7 years

Slingshot to Mars

- Mars
  Earth
  Venus
  Rocket

- Total time:
  1 year

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Hohmann Orbit to Jupiter

- Earth
  Jupiter
  Rocket

- Total time:
  2.72 years
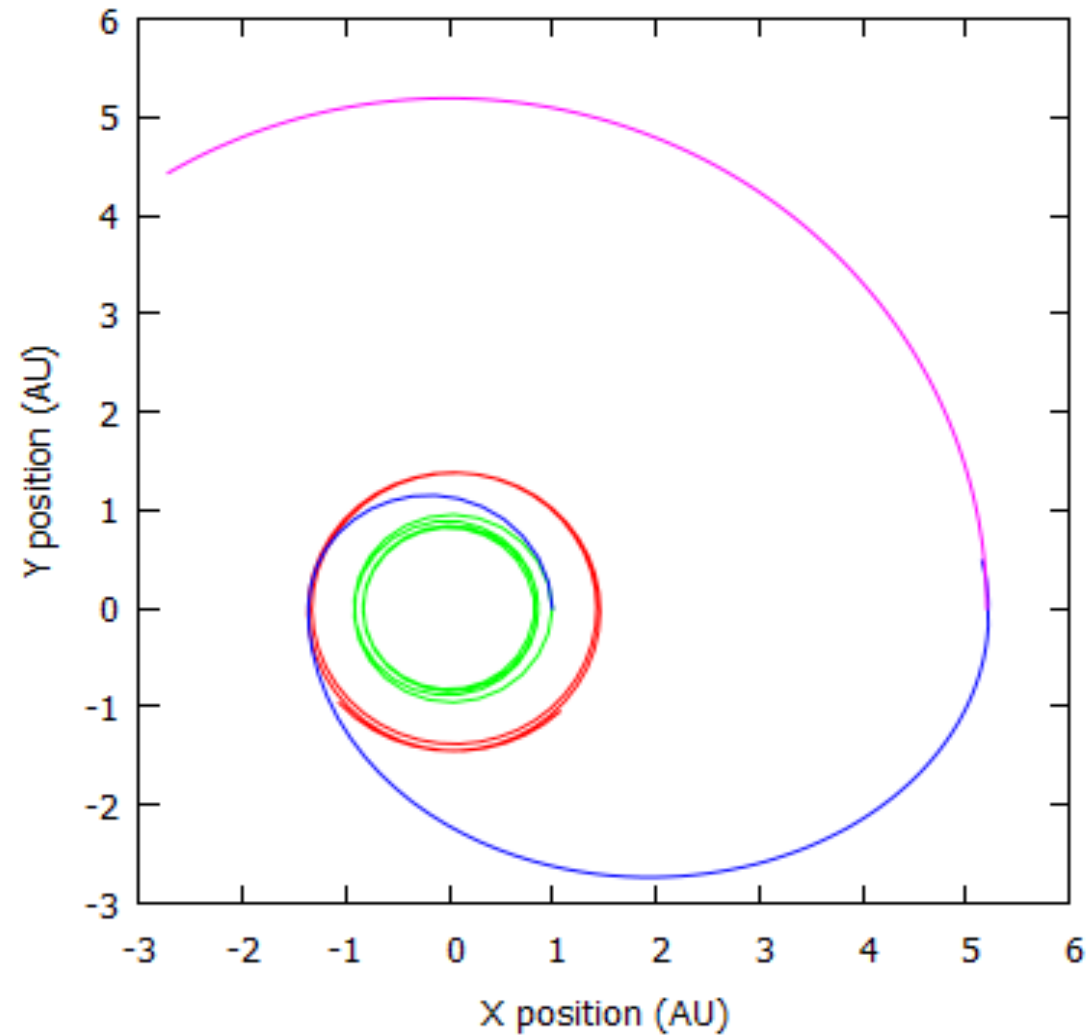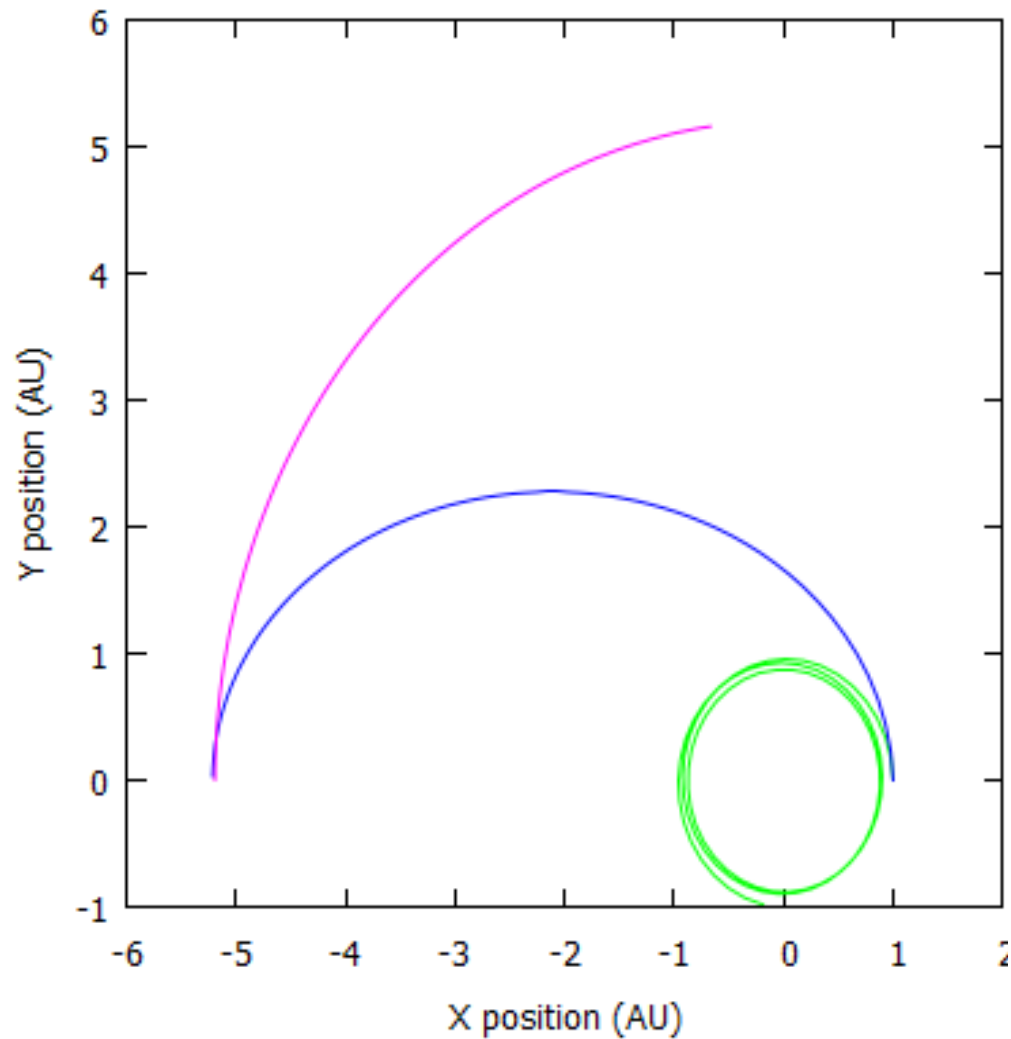
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Slingshot to Jupiter

- Mars
  Earth
  Jupiter
  Rocket

- Total time:

  4 years

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Time Efficiency

Method	Time (yr)
Hohmann (M)	0.70
Slingshot (M)	1.00
Hohmann (J)	2.72
Slingshot (J)	4.00

- Hohmann transfer is faster in both cases

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Time Efficiency

Fuel Efficiency

- Slingshot method uses lots of fuel to slow down

Method	Total boosts
Hohmann (M)	~20 km/s
Slingshot (M)	~81 km/s
Hohmann (J)	~17 km/s
Slingshot (J)	~19 km/s

Fuel Efficiency
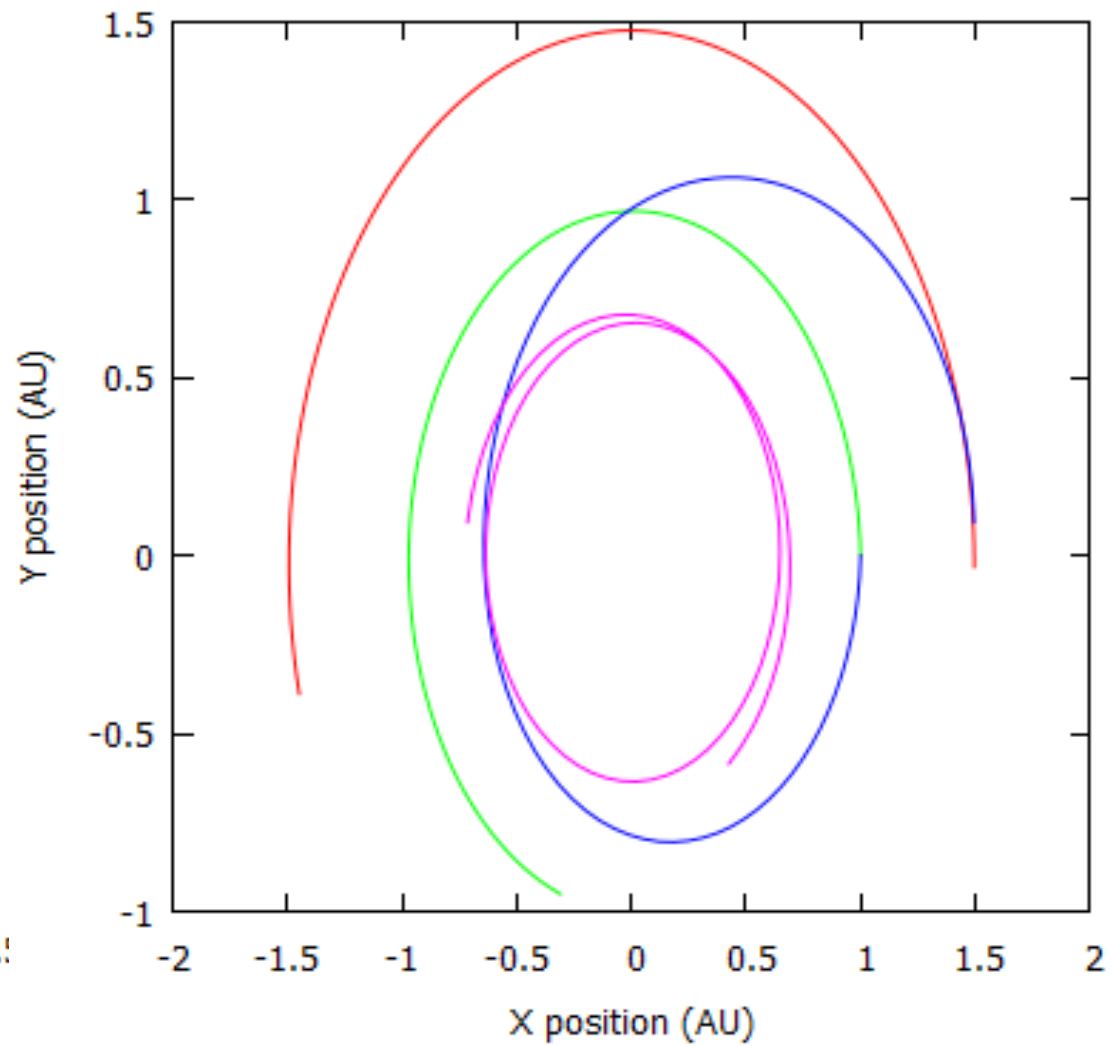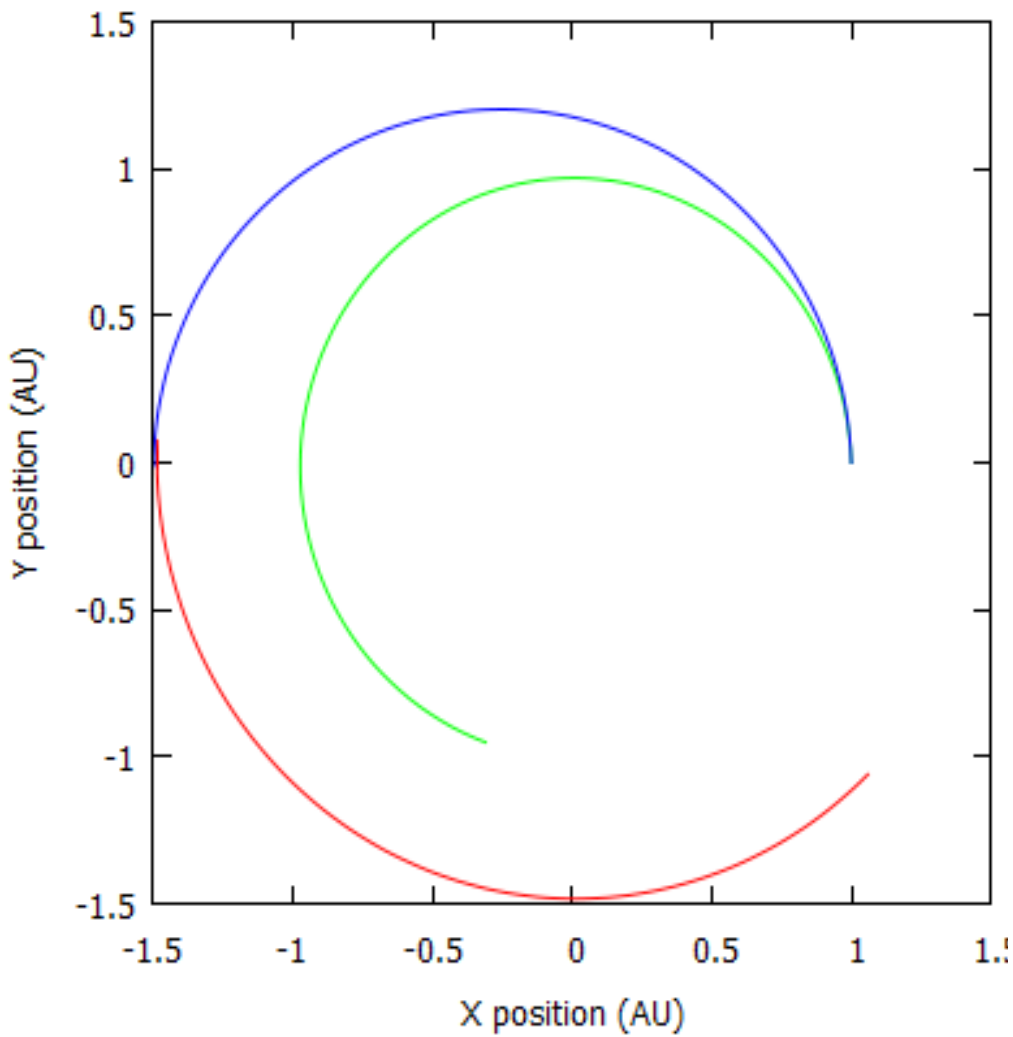
Which is the best?

- Hohmann transfer orbit is best suited for a trip to Mars

- Slingshot method better suited to traveling beyond our Solar System

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