



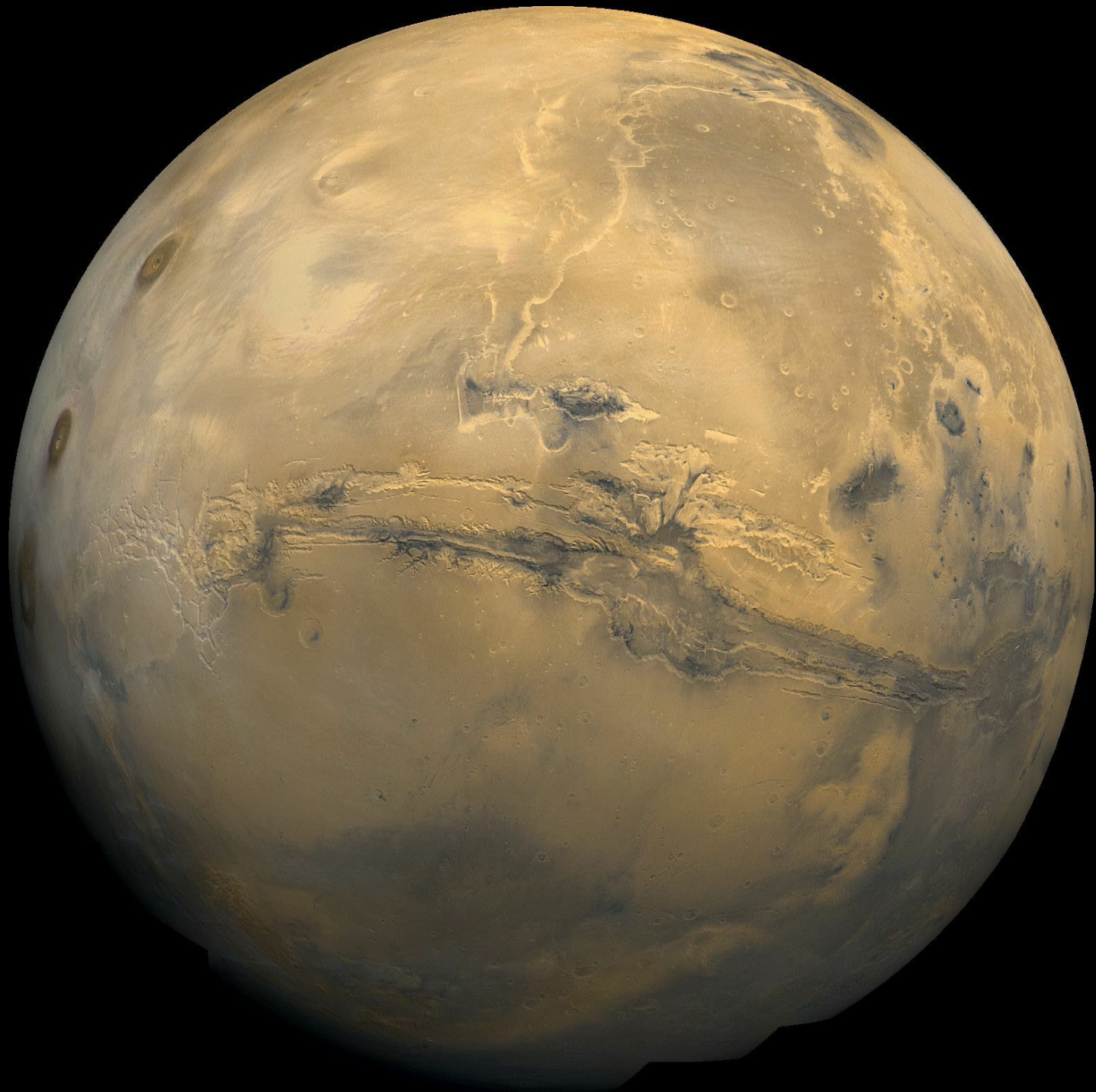
TALKS

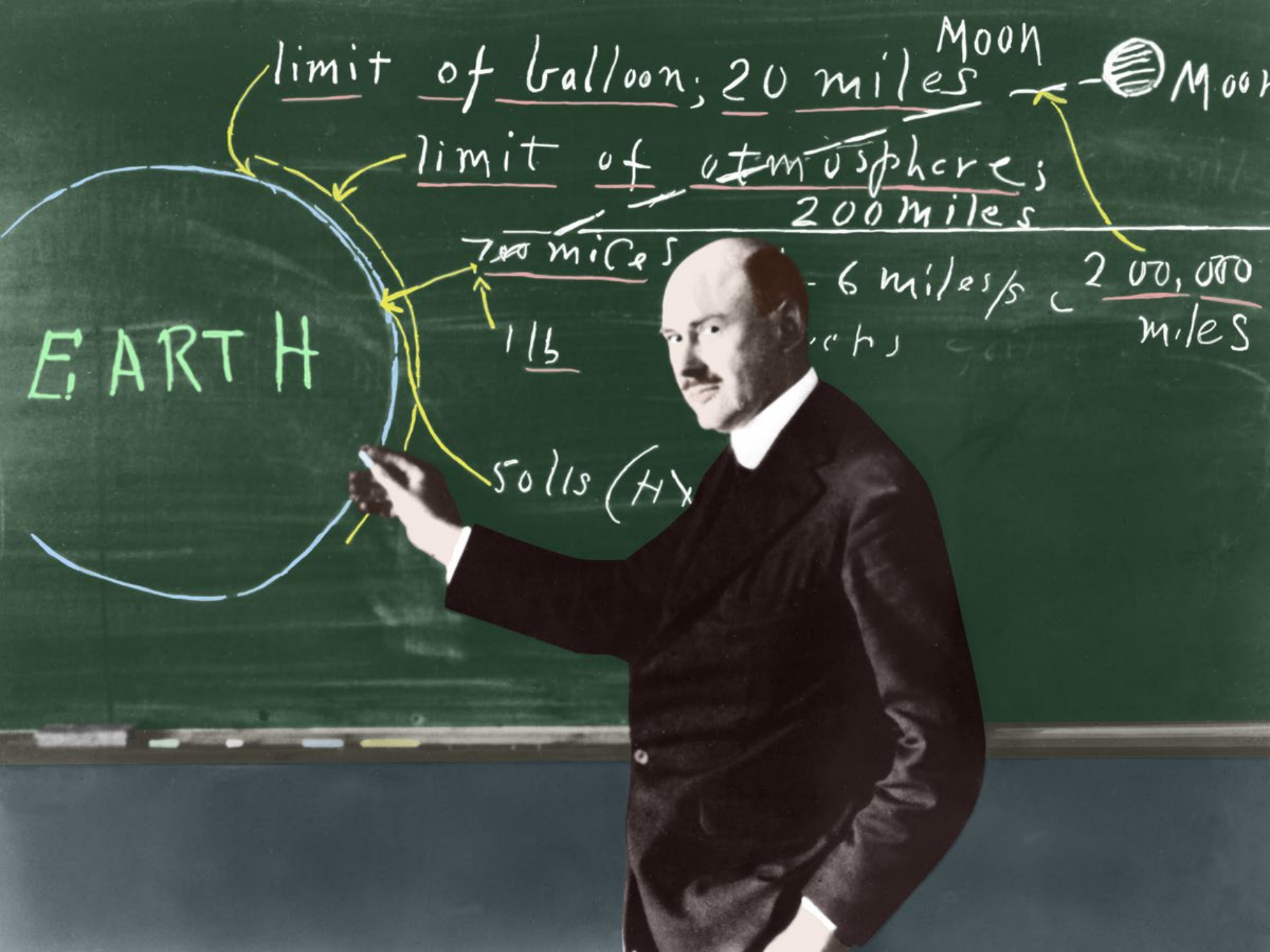
WHERE NASA COMES TO TALK TECH

EARTH TO MARS IN 3 GIANT LEAPS

DR. STAN LOVE
NASA ASTRONAUT

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limit of balloon; 20 miles

Moon



Moon

limit of atmosphere;
200 miles

200 miles

6 miles/s

200,000
miles

EARTH

115

50115 (Hx)

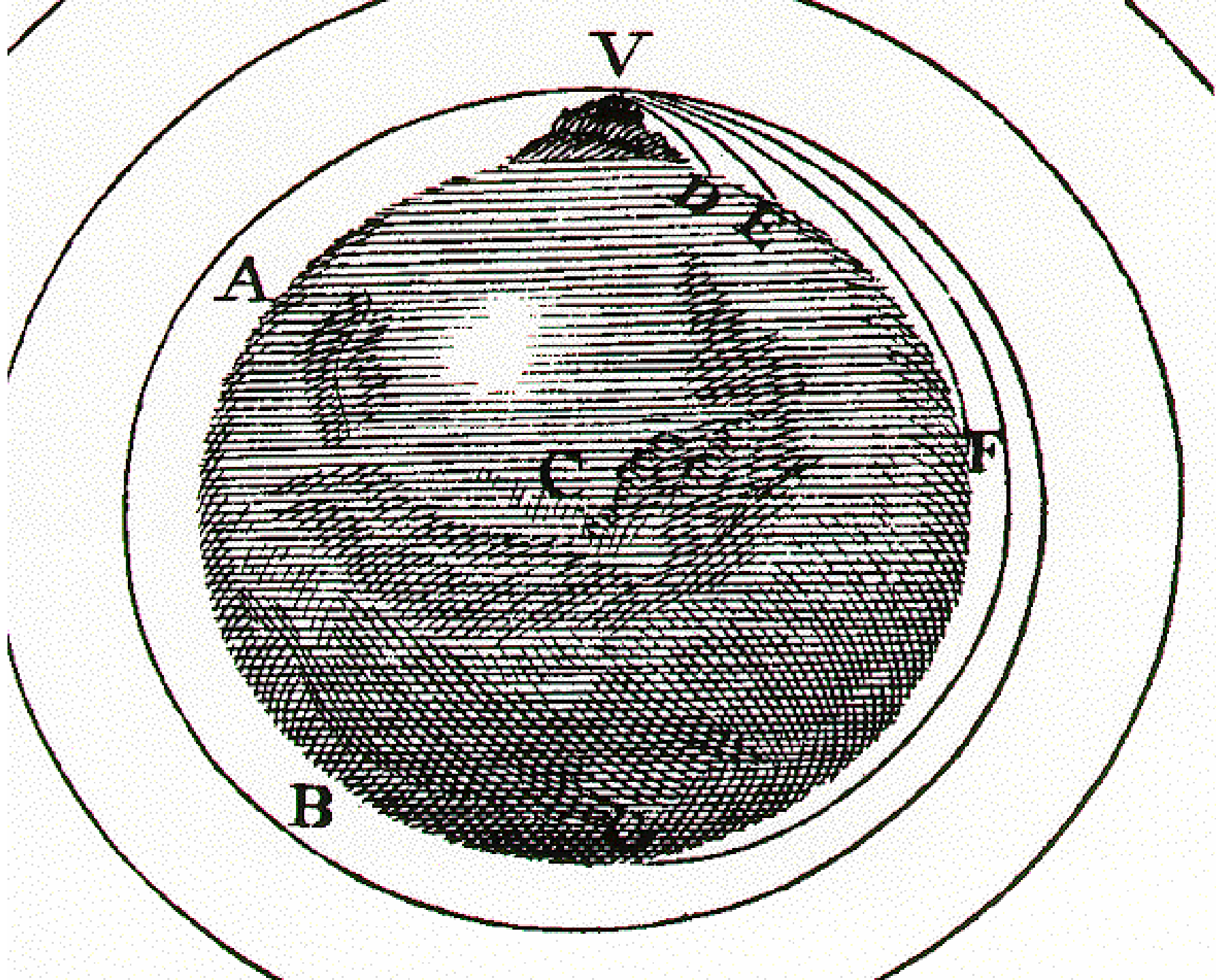
1. Low Earth Orbit
2. The Moon
3. Mars

1. Low Earth Orbit



8,000 miles





20,000 mph

99/100

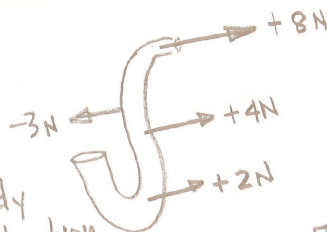
F

$$F = ma$$

F = FORCE APPLIED

m = mass of body

a = body's acceleration



$$F_1 + F_2 + \dots + F_n = F_{\text{net}} = ma$$

$$F_{\text{net}} = ma = m \frac{dv}{dt} = \frac{d(mv)}{dt} = \frac{dp}{dt}$$

$$F_{\text{total}} = m \Delta v / \Delta t$$

$$= (200 \text{ kg})(25 \text{ m/s} - 0 \text{ m/s}) / (3 \text{ s})$$

$$= 1.5 \text{ kN}$$

$$F_{\text{net}} = \frac{dp}{dt}$$

$$I = \int F dt$$



$$F_w = mg$$

$$= (2 \text{ kg})(9.8 \text{ m/s}^2)$$

$$= 19.6 \text{ N}$$

$$I = \Delta p = m \Delta v = m \Delta v$$

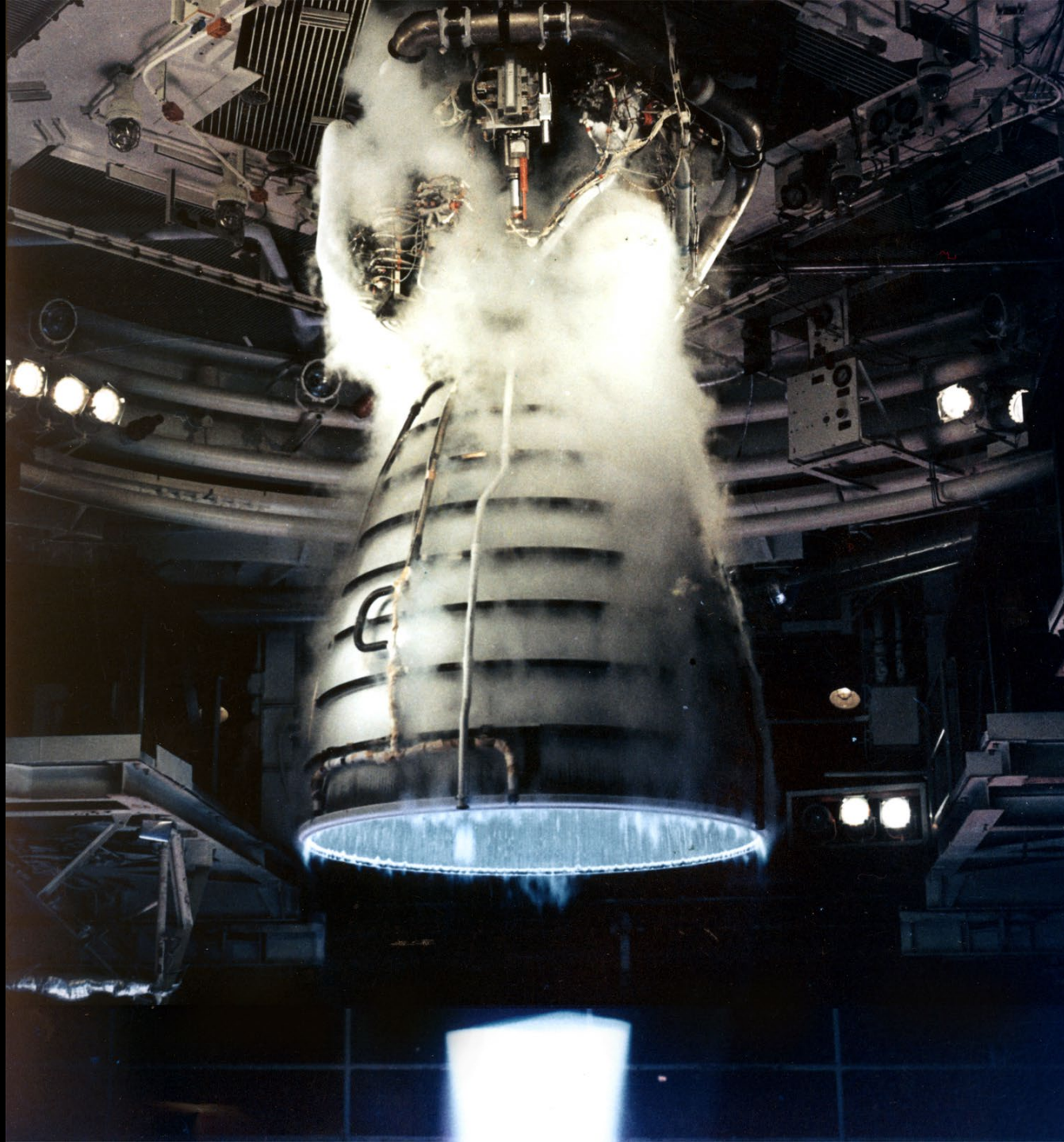
$$F_{\text{net}} = ma_{\text{cm}}, \quad F + v \frac{dm}{dt} = m \frac{dv}{dt}$$

$$\boxed{F = ma}$$





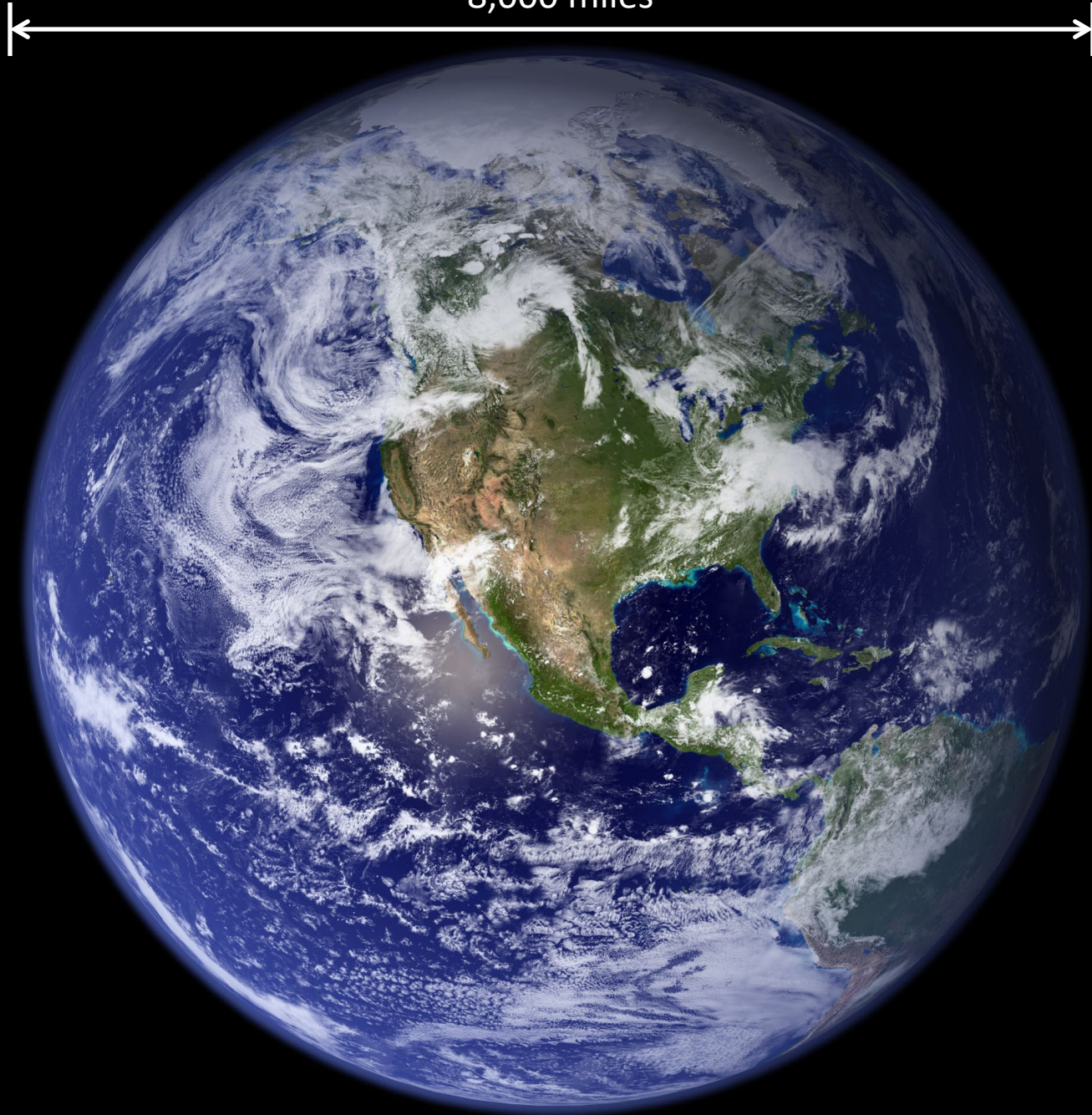






2. The Moon

8,000 miles













240,000 miles

1,000 ×



A large, semi-transparent red 'X' mark is centered on the slide, crossing over the word 'Distance'.

Distance

Speed

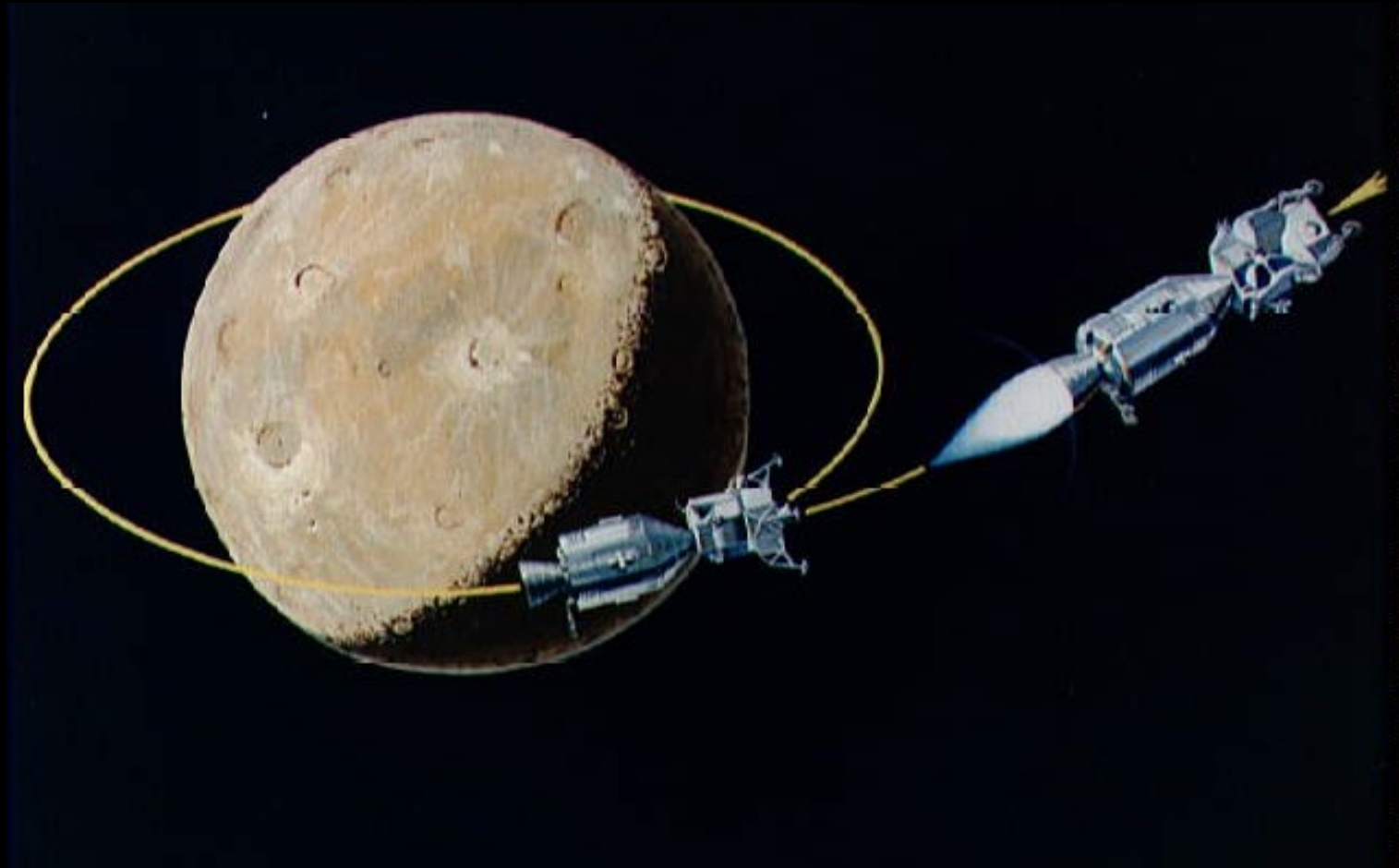
20,000 mph



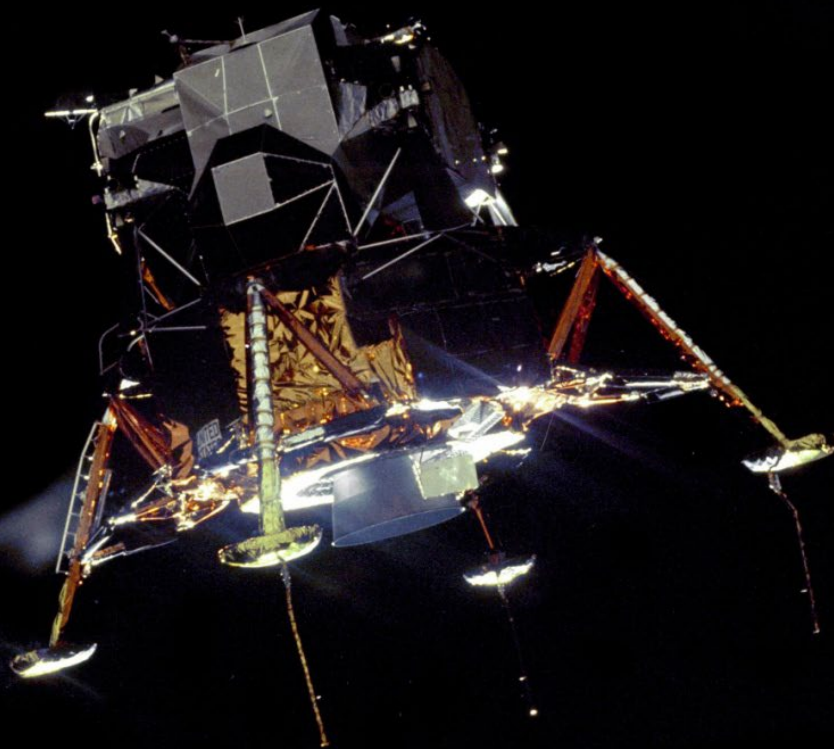
20,000 mph
8,200 mph



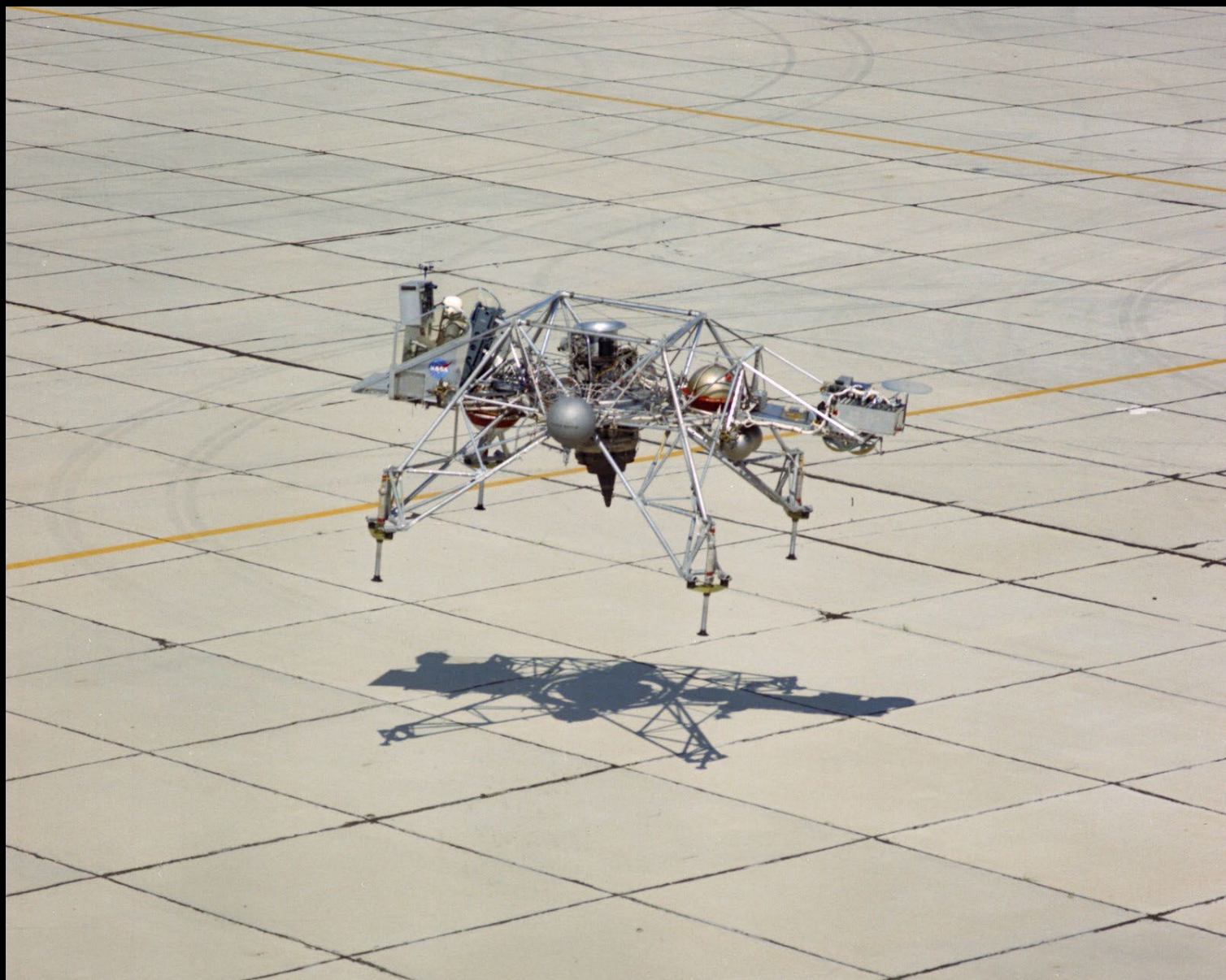
20,000 mph
8,200 mph
2,400 mph



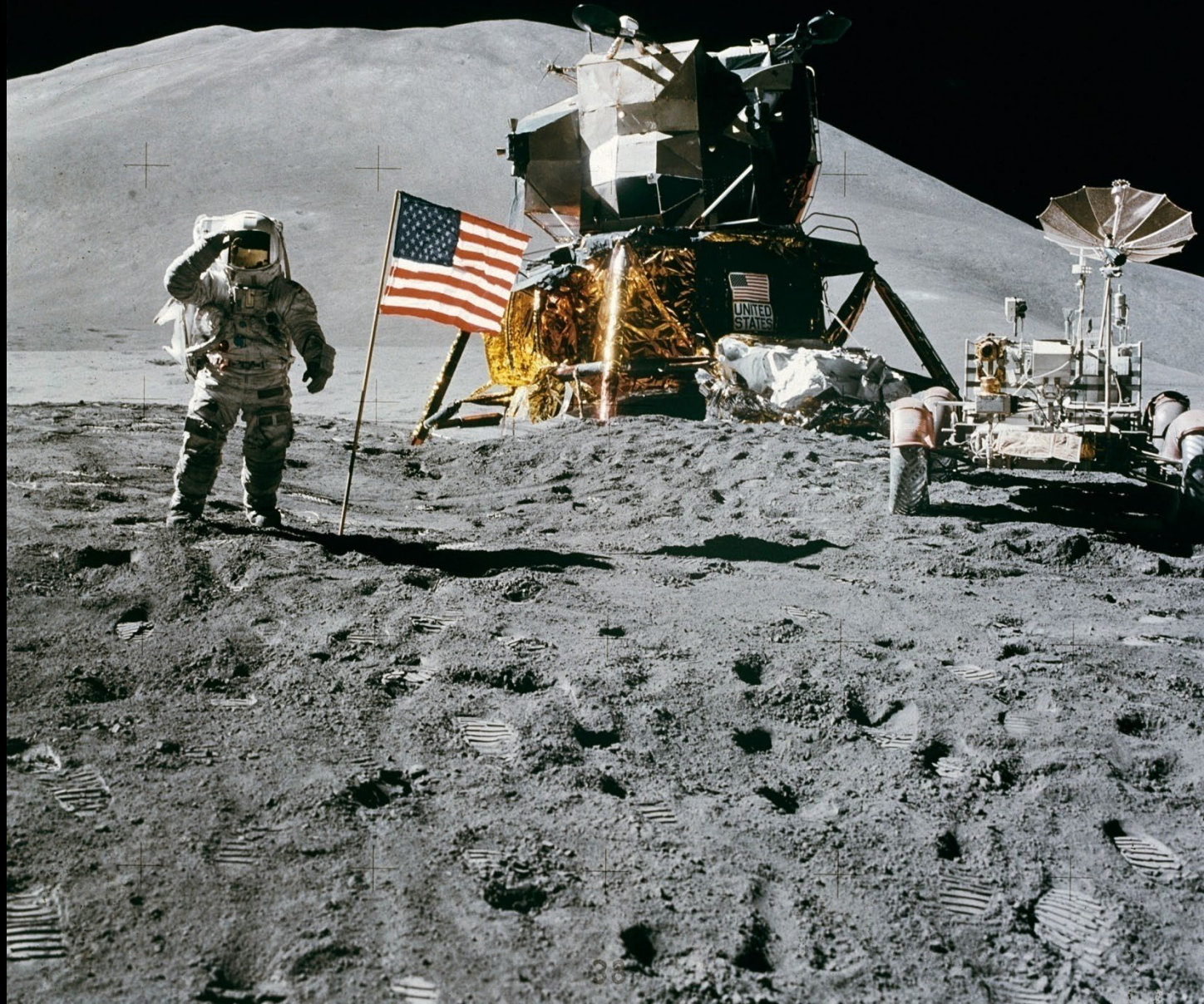
20,000 mph
8,200 mph
2,400 mph
3,900 mph



20,000 mph
8,200 mph
2,400 mph
3,900 mph
700 mph



20,000 mph
8,200 mph
2,400 mph
3,900 mph
700 mph
0 mph



20,000 mph
8,200 mph
2,400 mph
3,900 mph
700 mph
0 mph
700 mph



20,000 mph

8,200 mph

2,400 mph

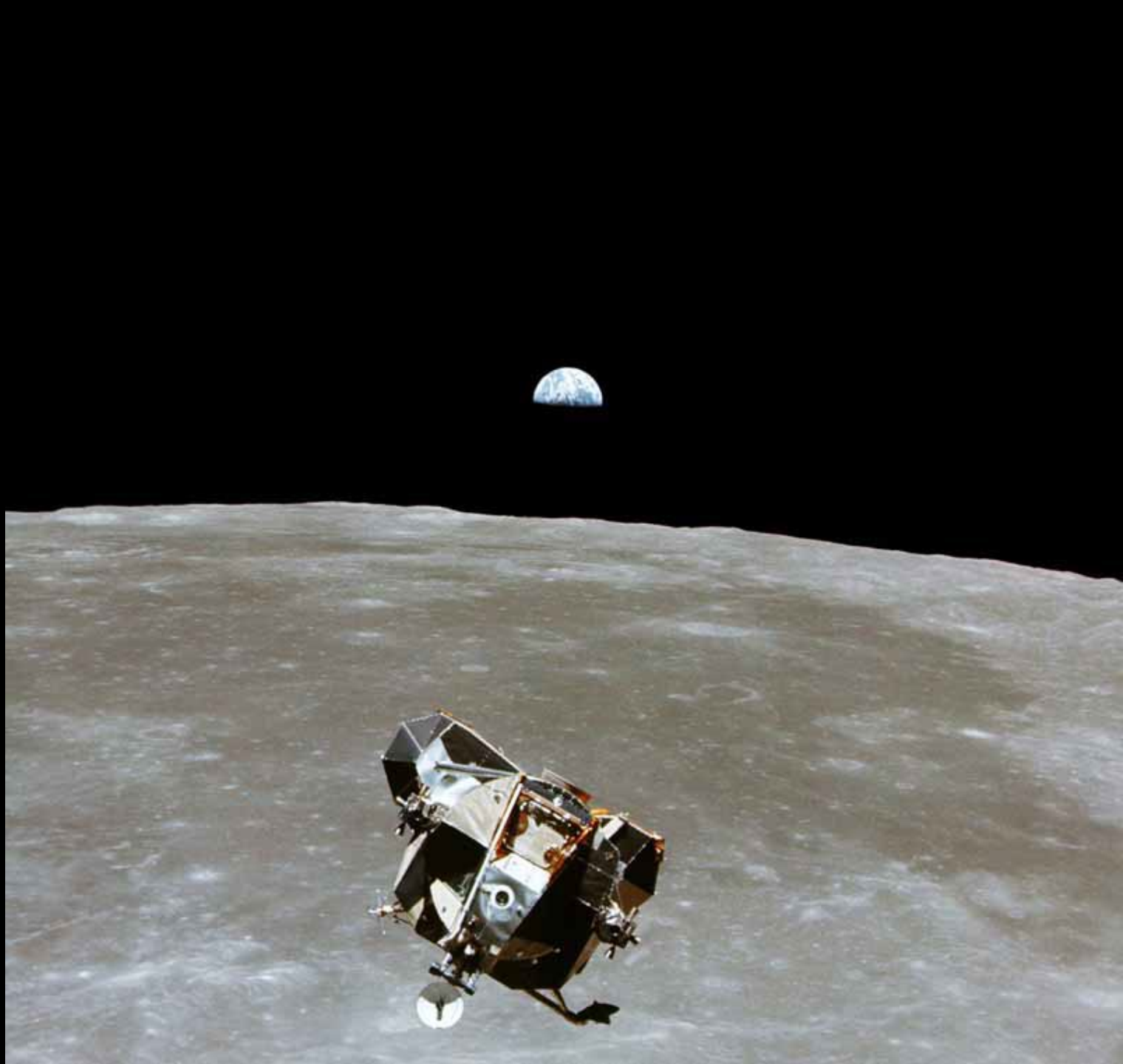
3,900 mph

700 mph

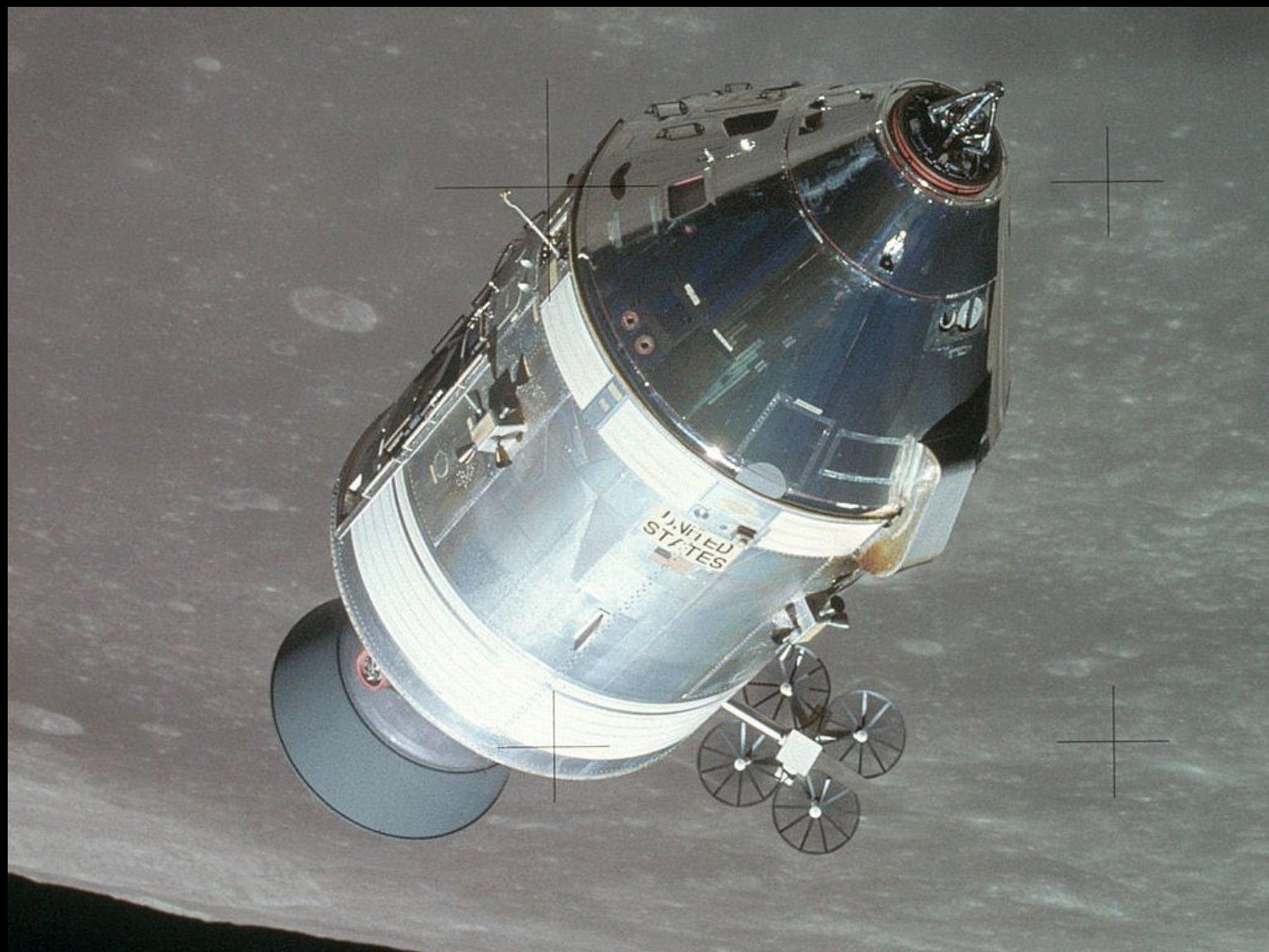
0 mph

700 mph

3,900 mph



20,000 mph
8,200 mph
2,400 mph
3,900 mph
700 mph
0 mph
700 mph
3,900 mph
2,400 mph



20,000 mph
8,200 mph
2,400 mph
3,900 mph
700 mph
0 mph
700 mph
3,900 mph
2,400 mph
0 mph

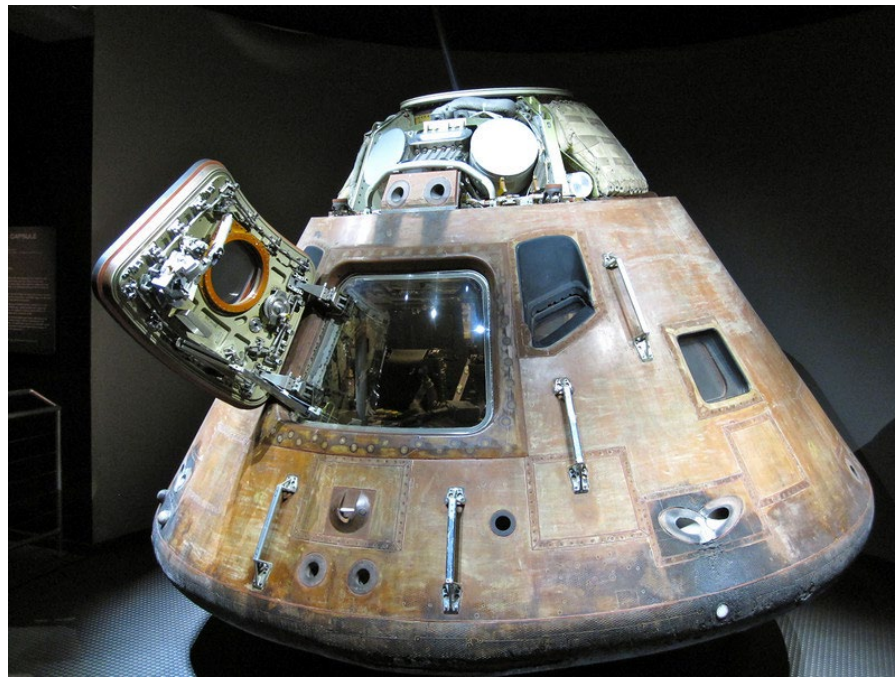


20,000 mph
8,200 mph
2,400 mph
3,900 mph
700 mph
0 mph
700 mph
3,900 mph
2,400 mph
0 mph
+ 0 mph



42,000 mph





6 tons



+



×33

+



×4

+



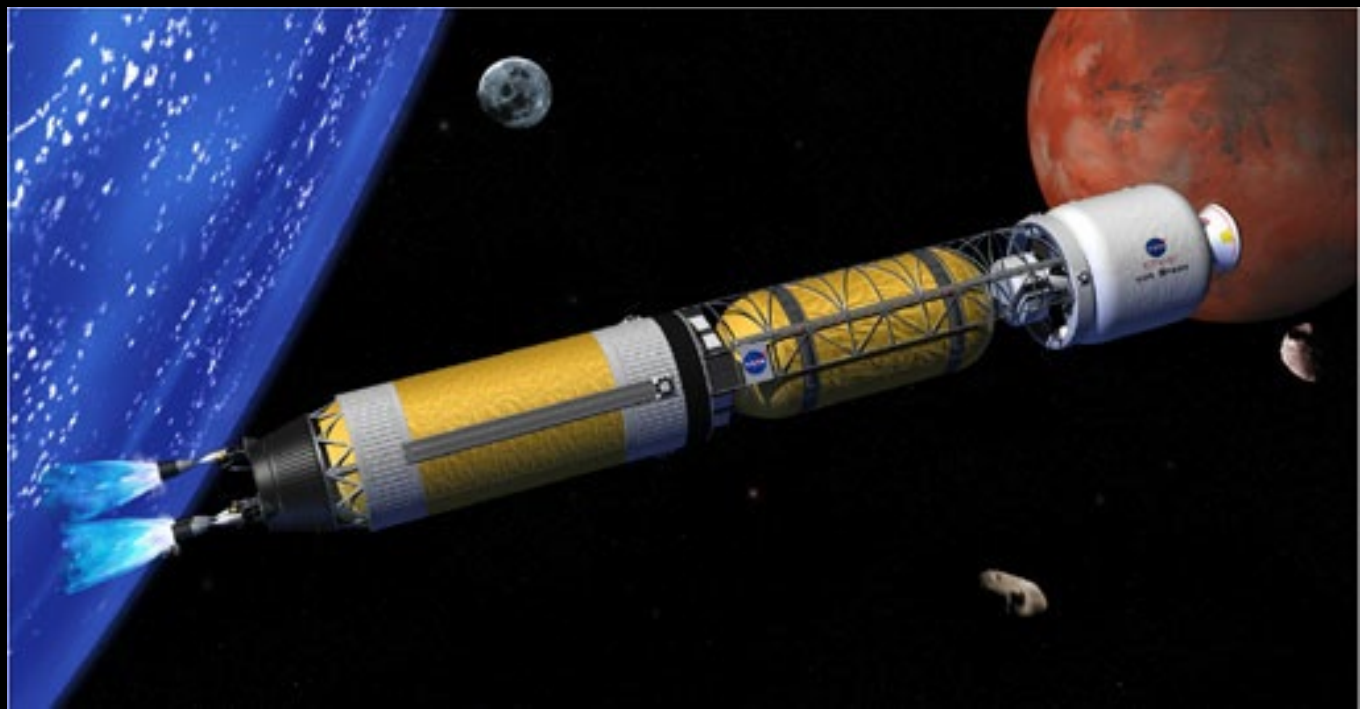
×1

3. Mars

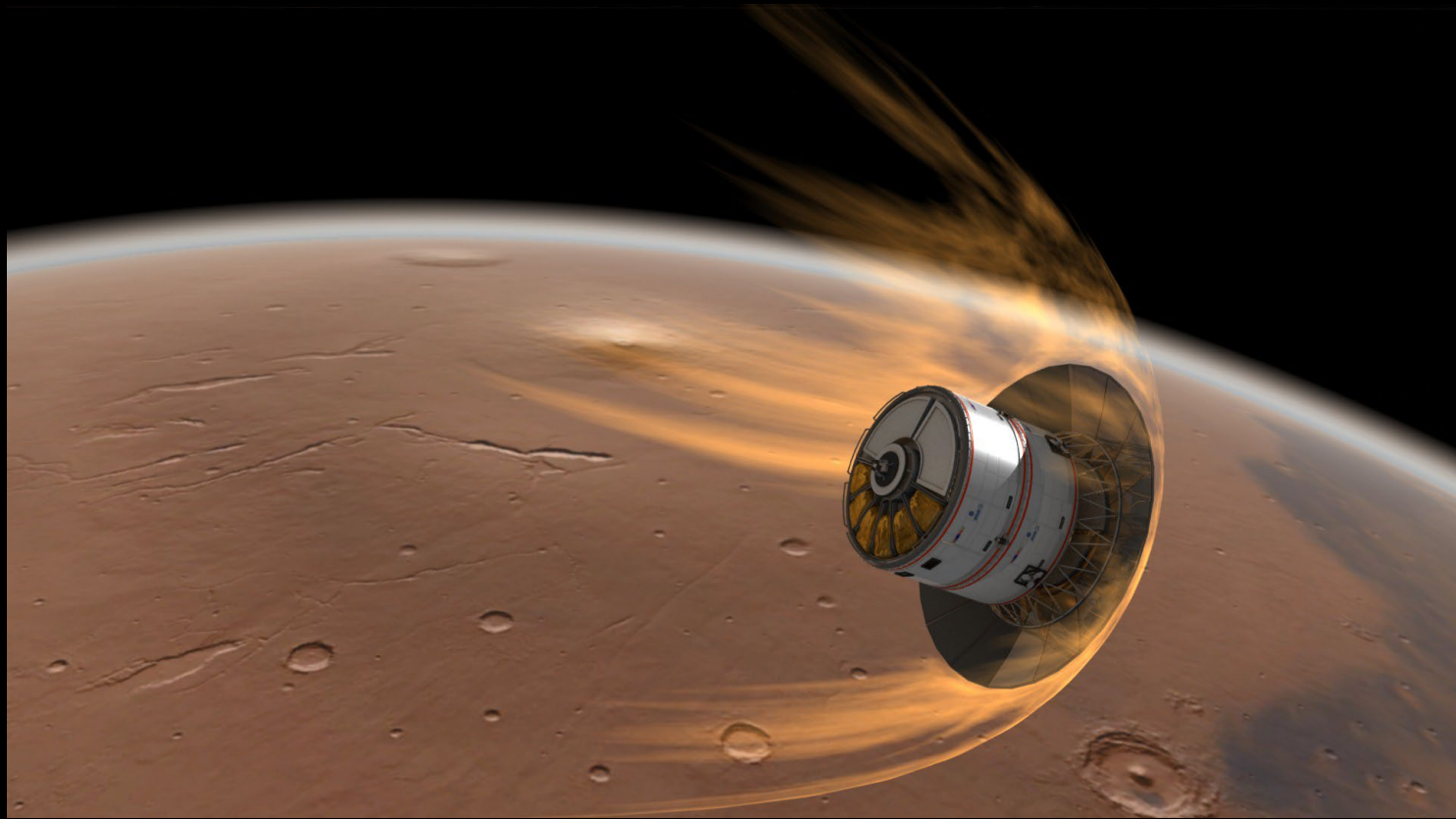
20,000 mph



20,000 mph
9,000 mph



20,000 mph
9,000 mph
0 mph

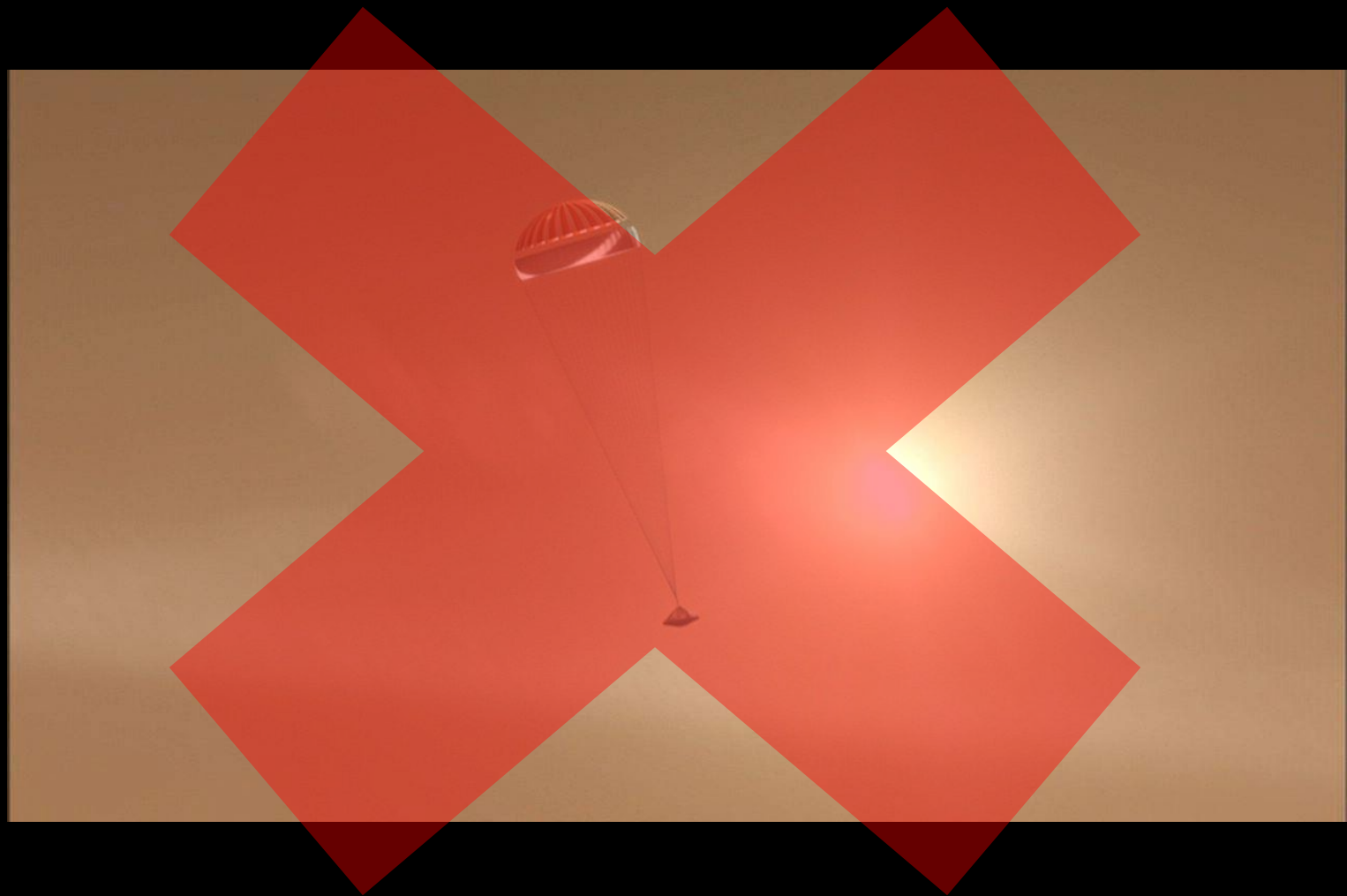


20,000 mph

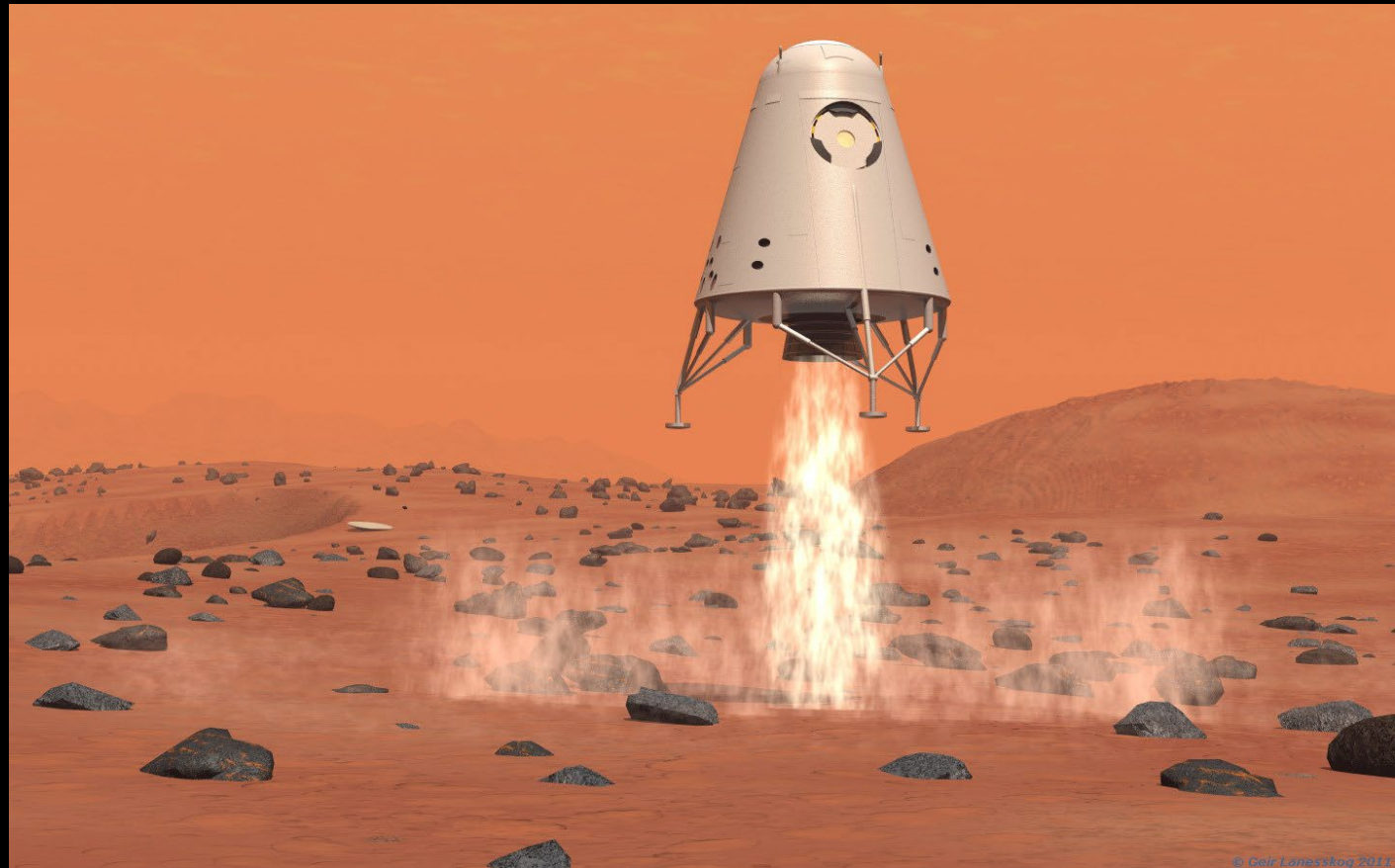
9,000 mph

0 mph

0 mph



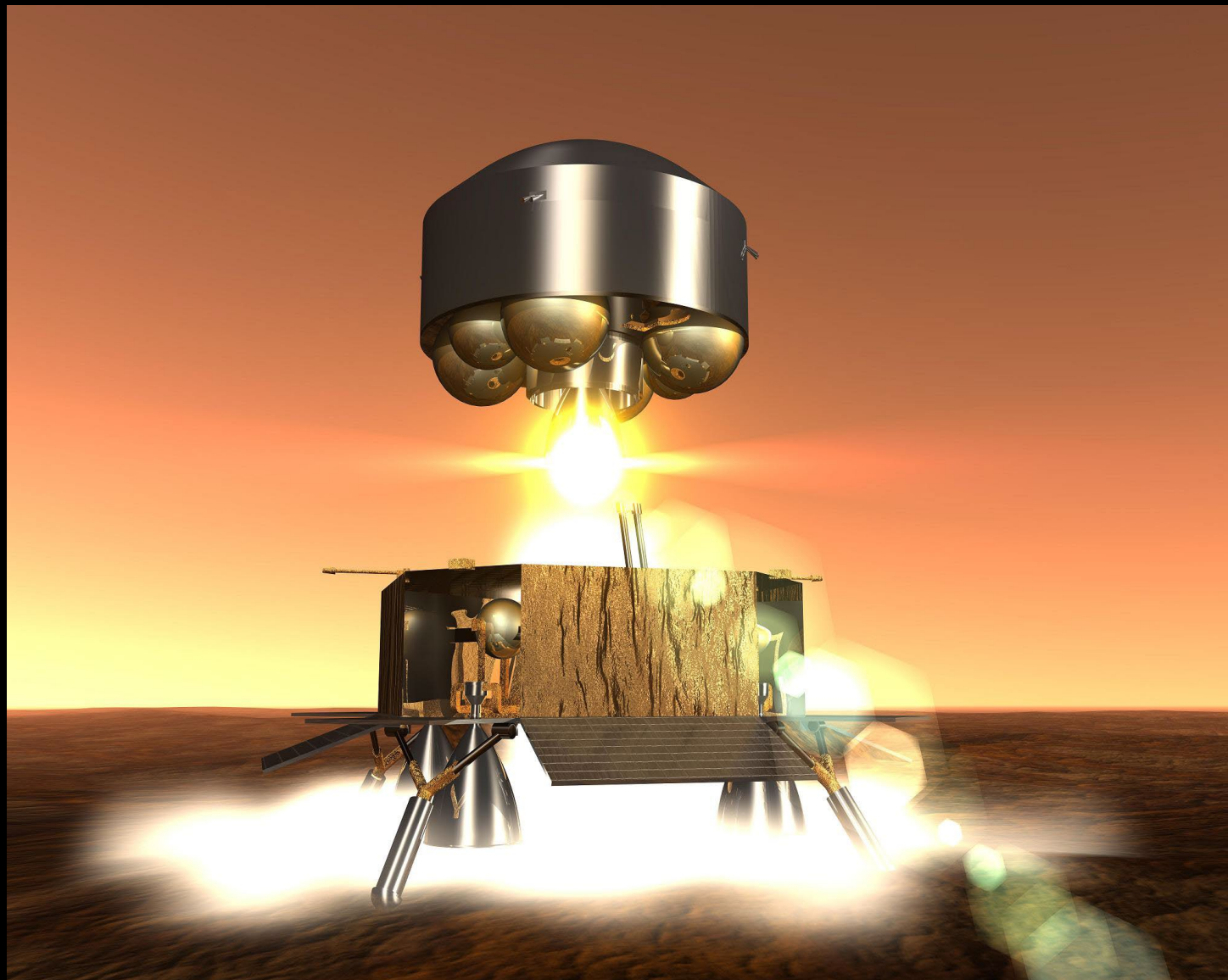
20,000 mph
9,000 mph
0 mph
2,000 mph



20,000 mph
9,000 mph
0 mph
2,000 mph
0 mph



20,000 mph
9,000 mph
0 mph
2,000 mph
0 mph
17,000 mph



20,000 mph

9,000 mph

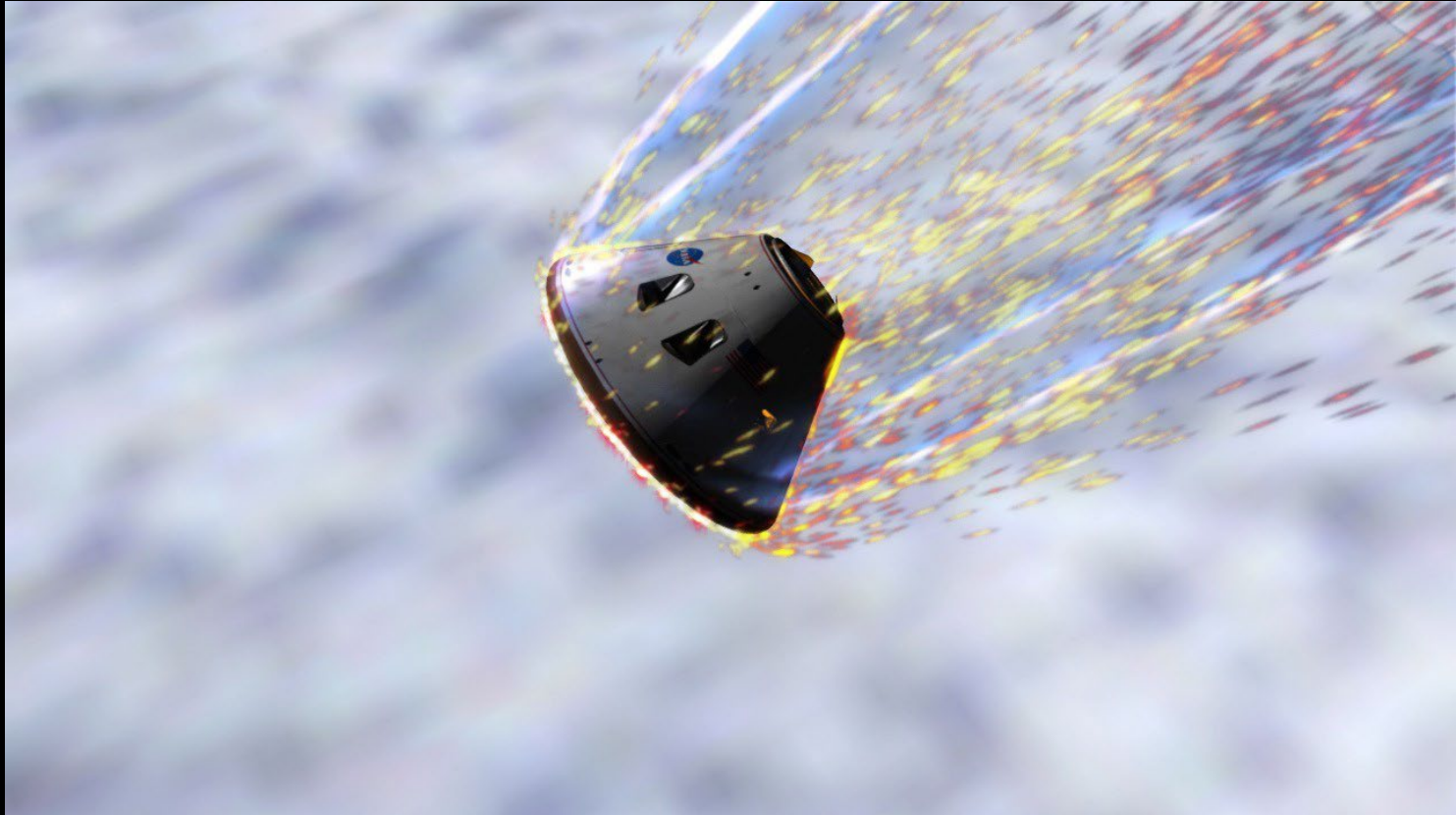
0 mph

2,000 mph

0 mph

17,000 mph

0 mph



20,000 mph

9,000 mph

0 mph

2,000 mph

0 mph

17,000 mph

0 mph

+ 0 mph



48,000 mph



Speed

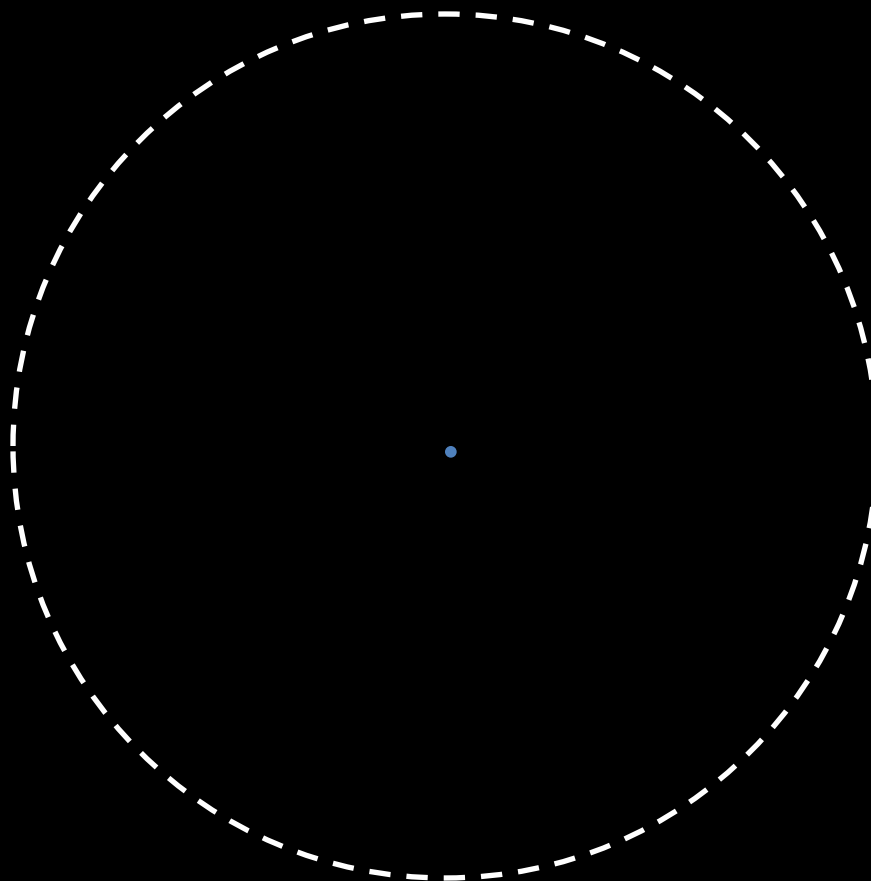
Distance

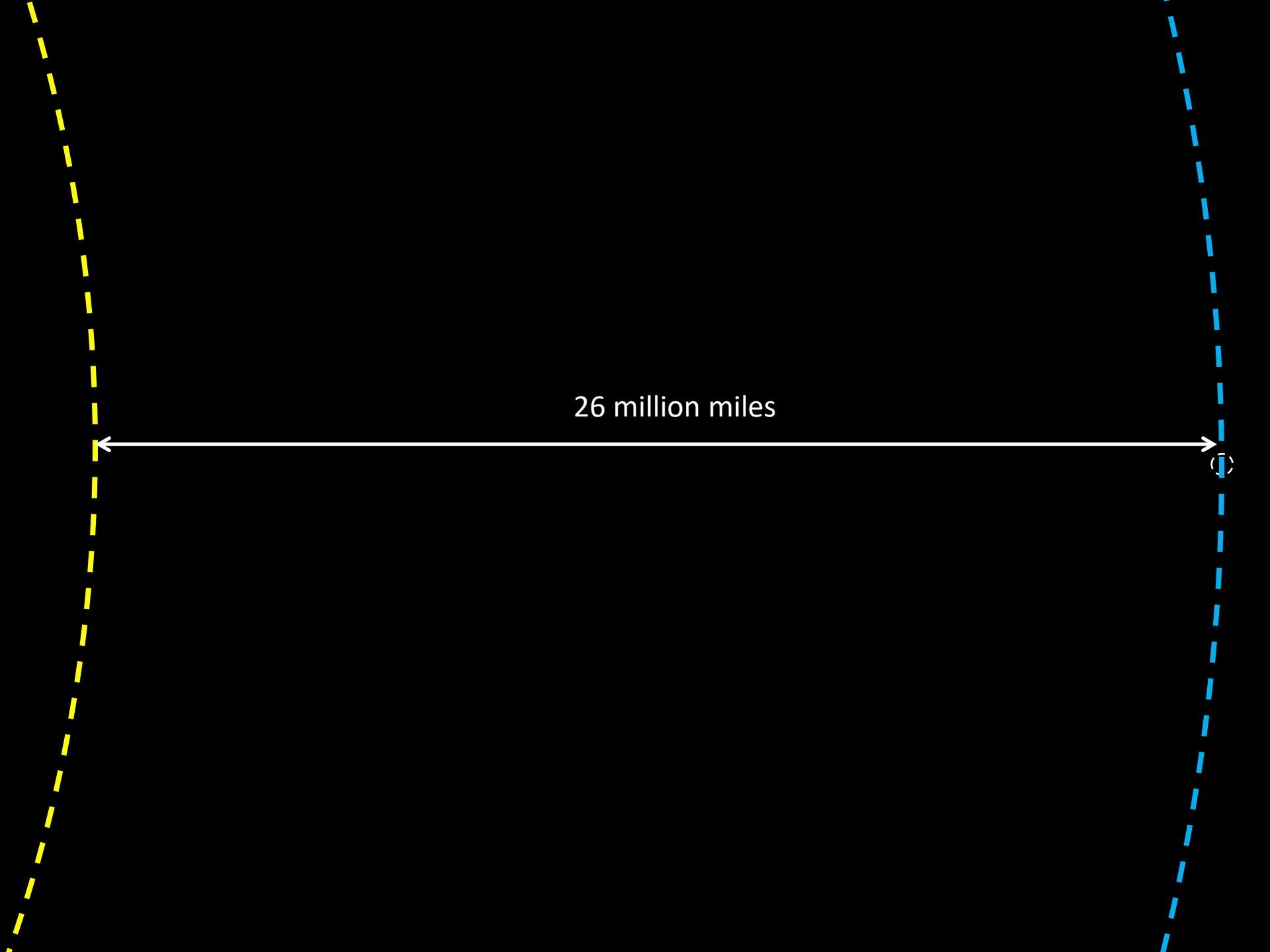


240,000 miles



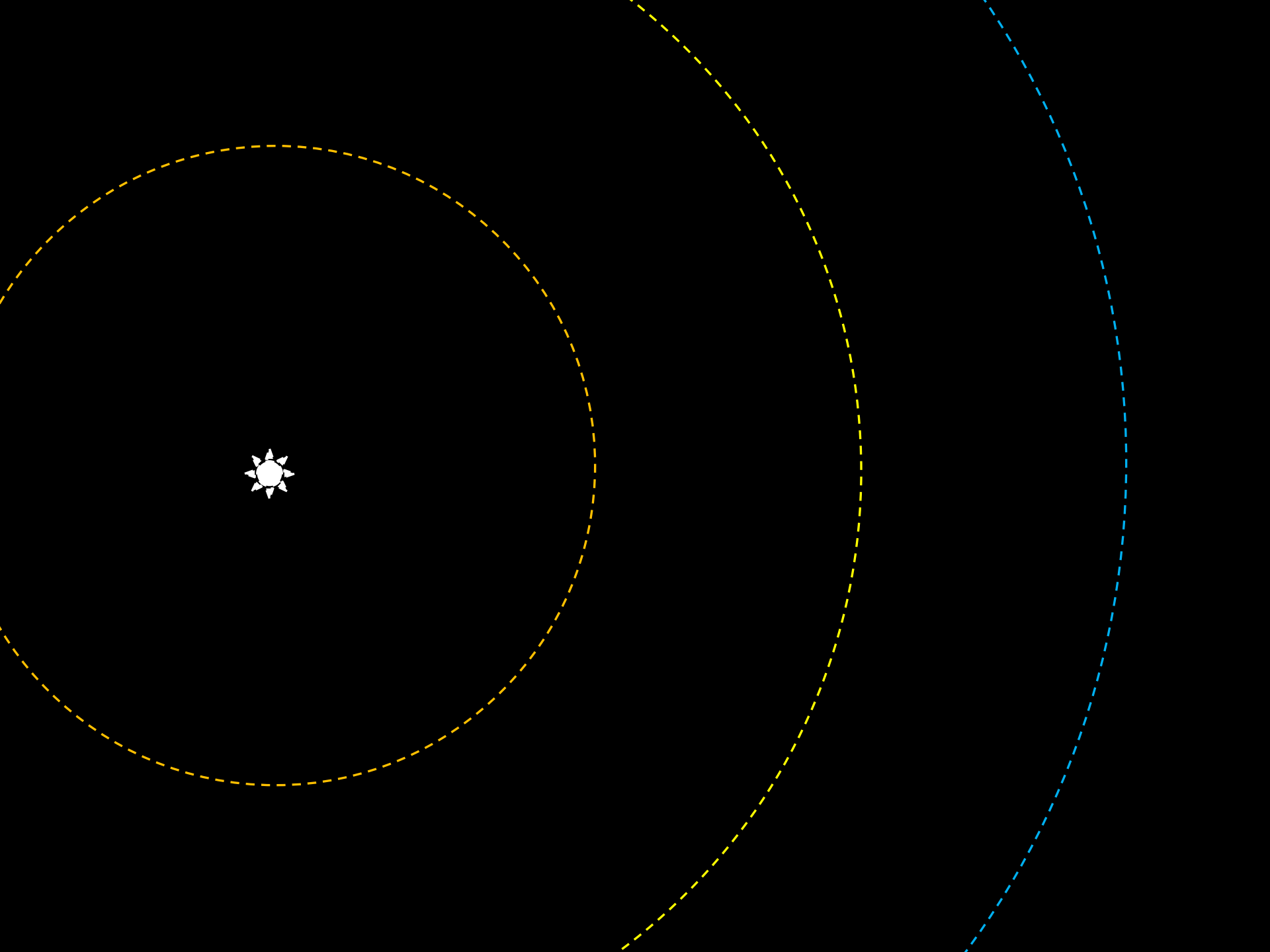
1/2 million miles

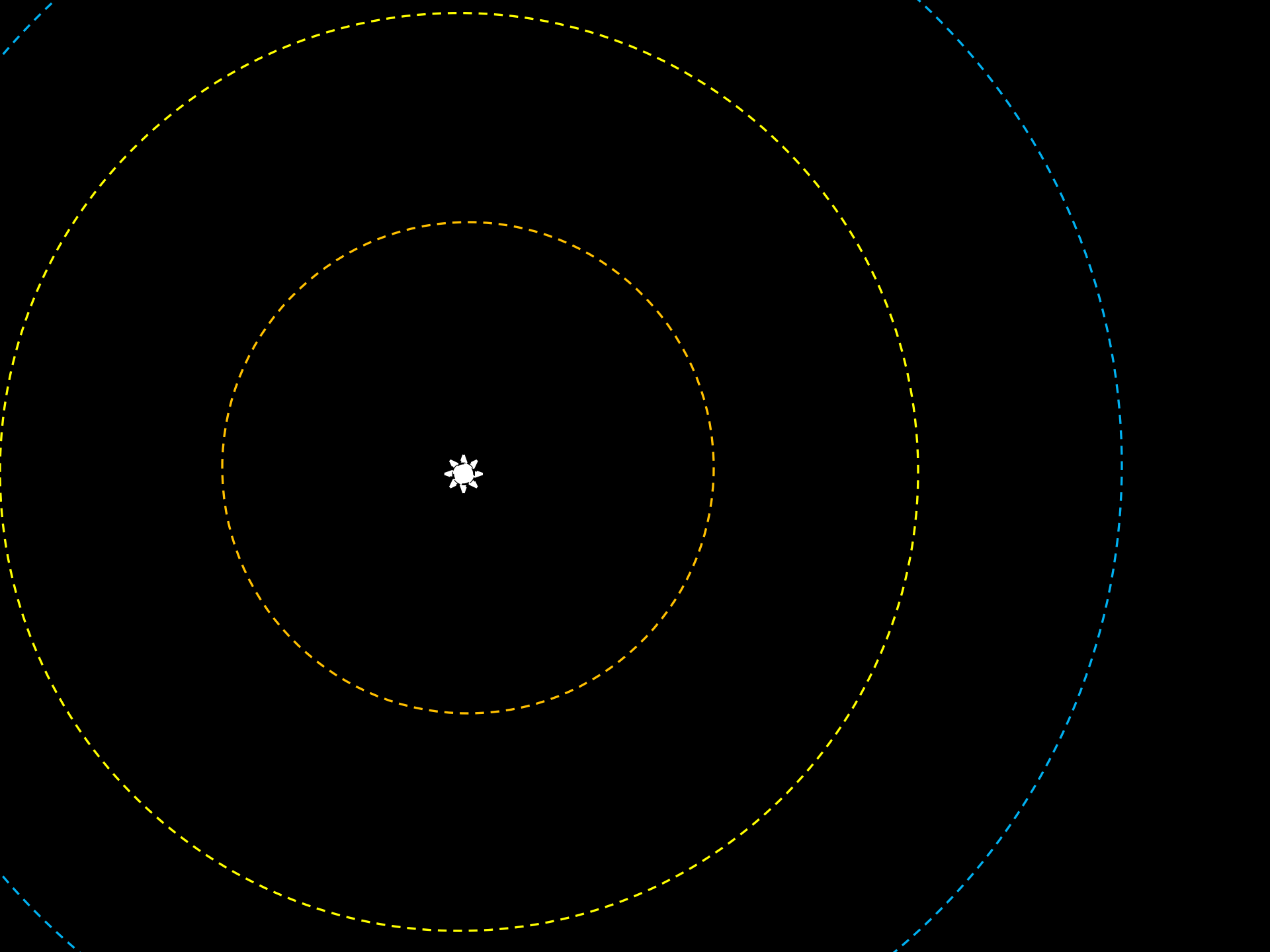


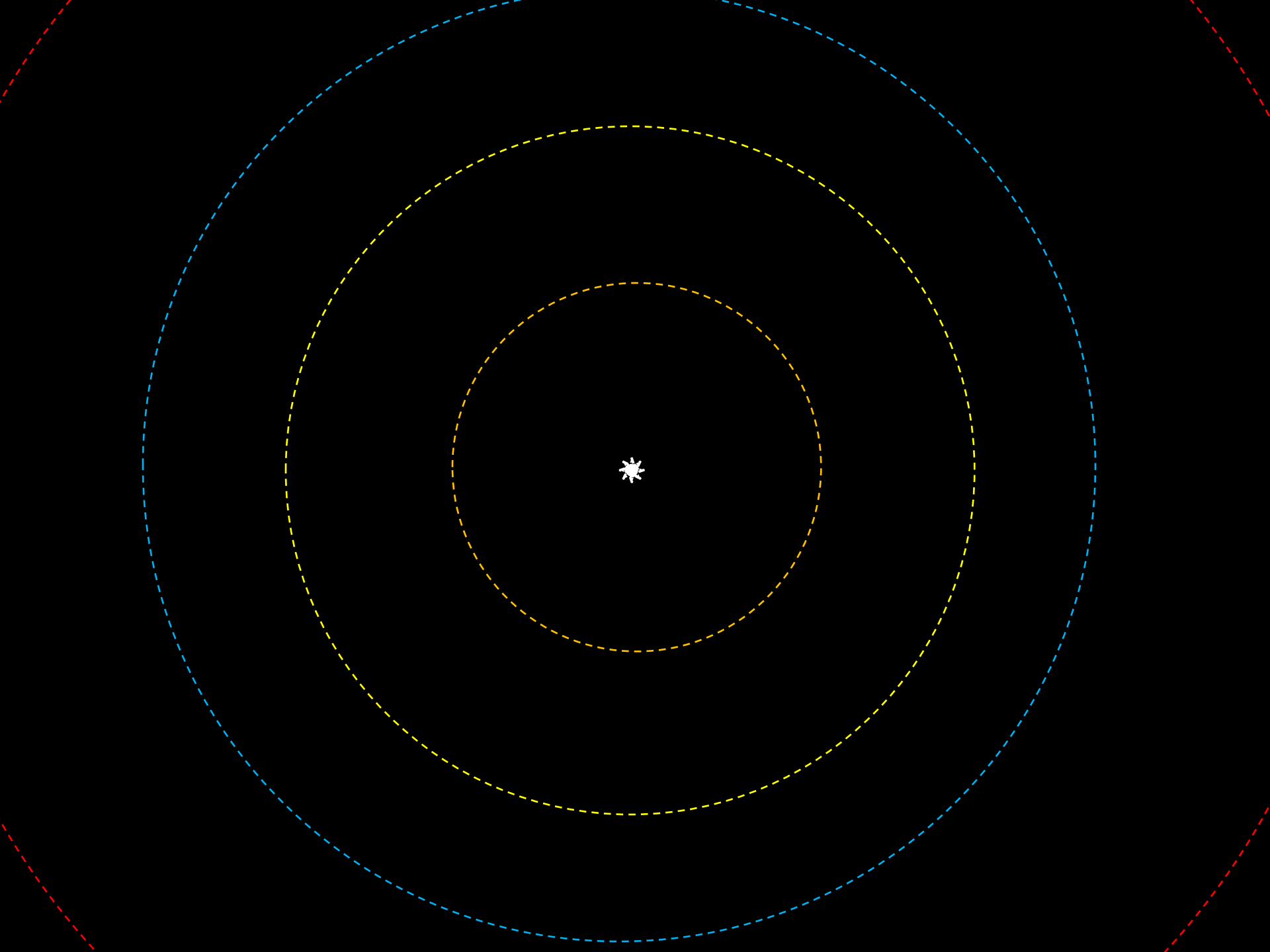


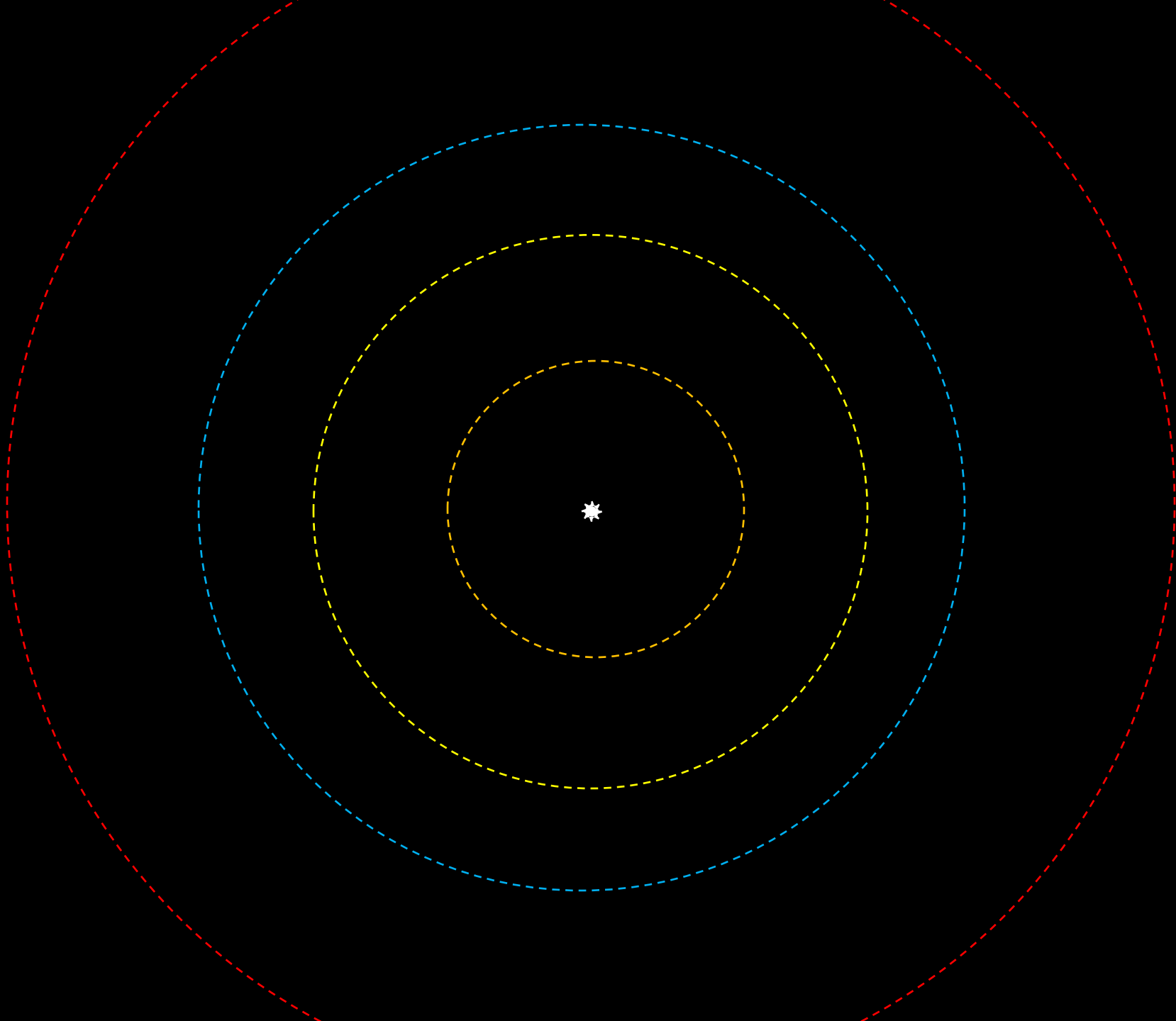
26 million miles

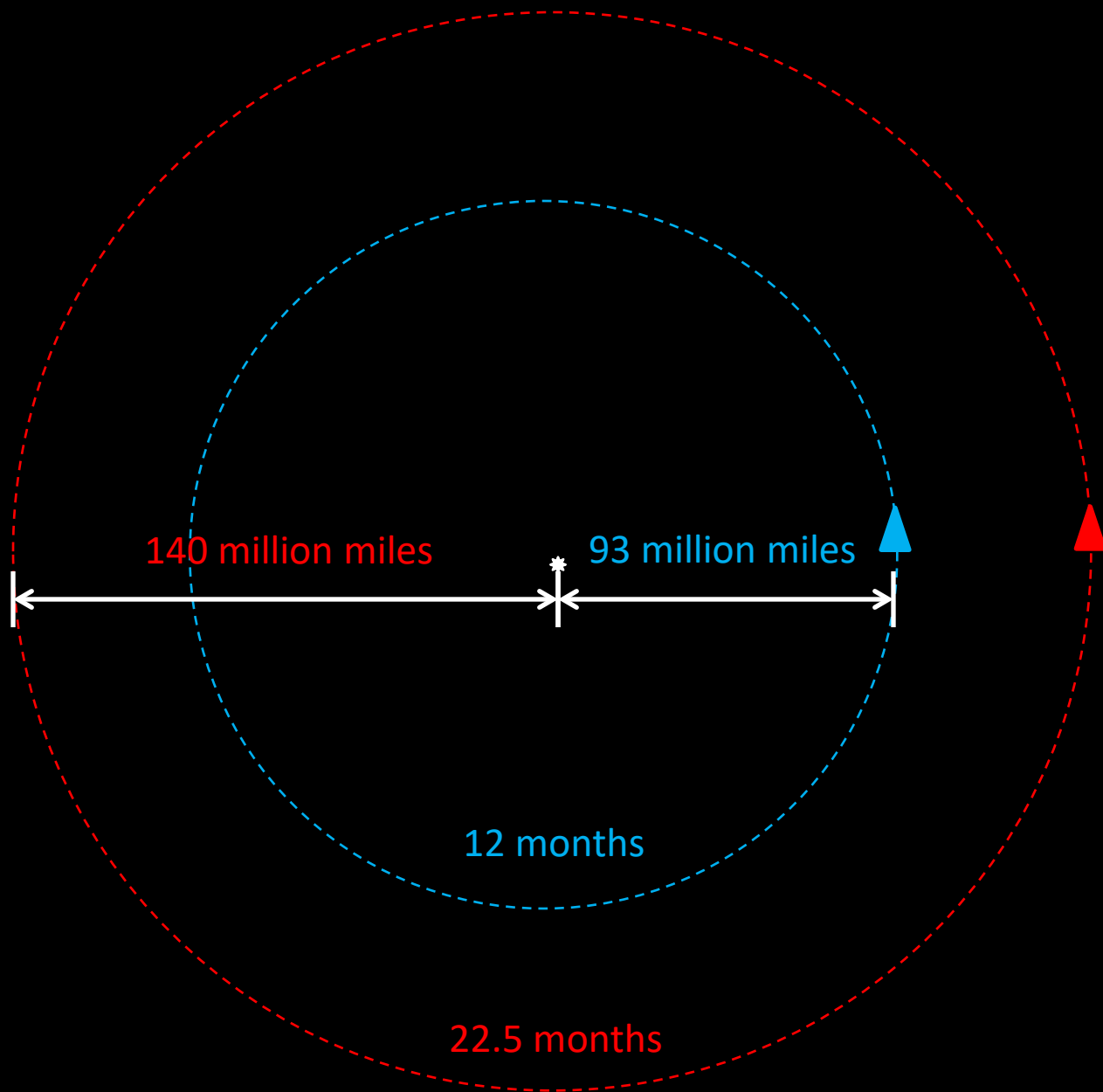










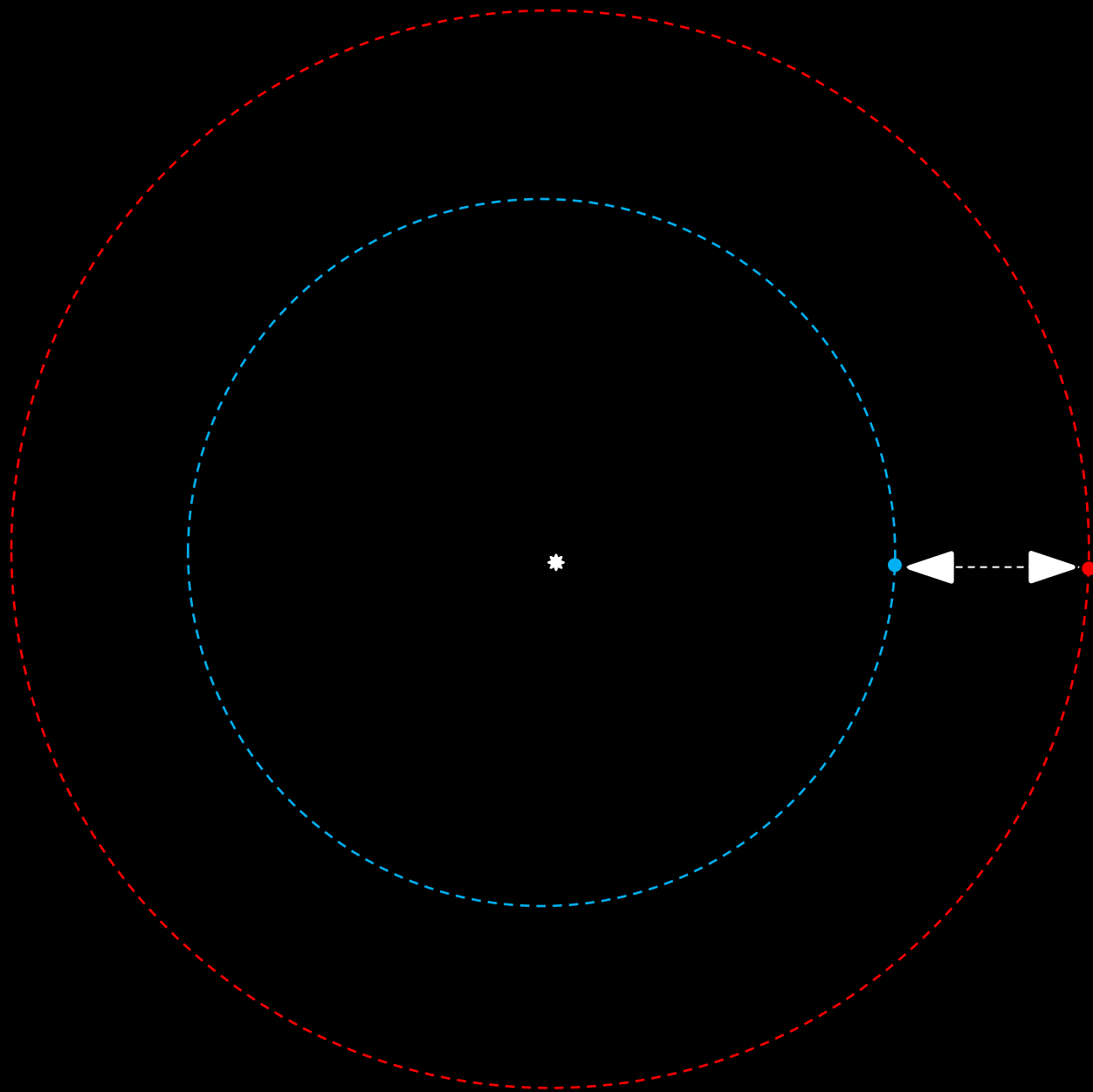


1,000 ×



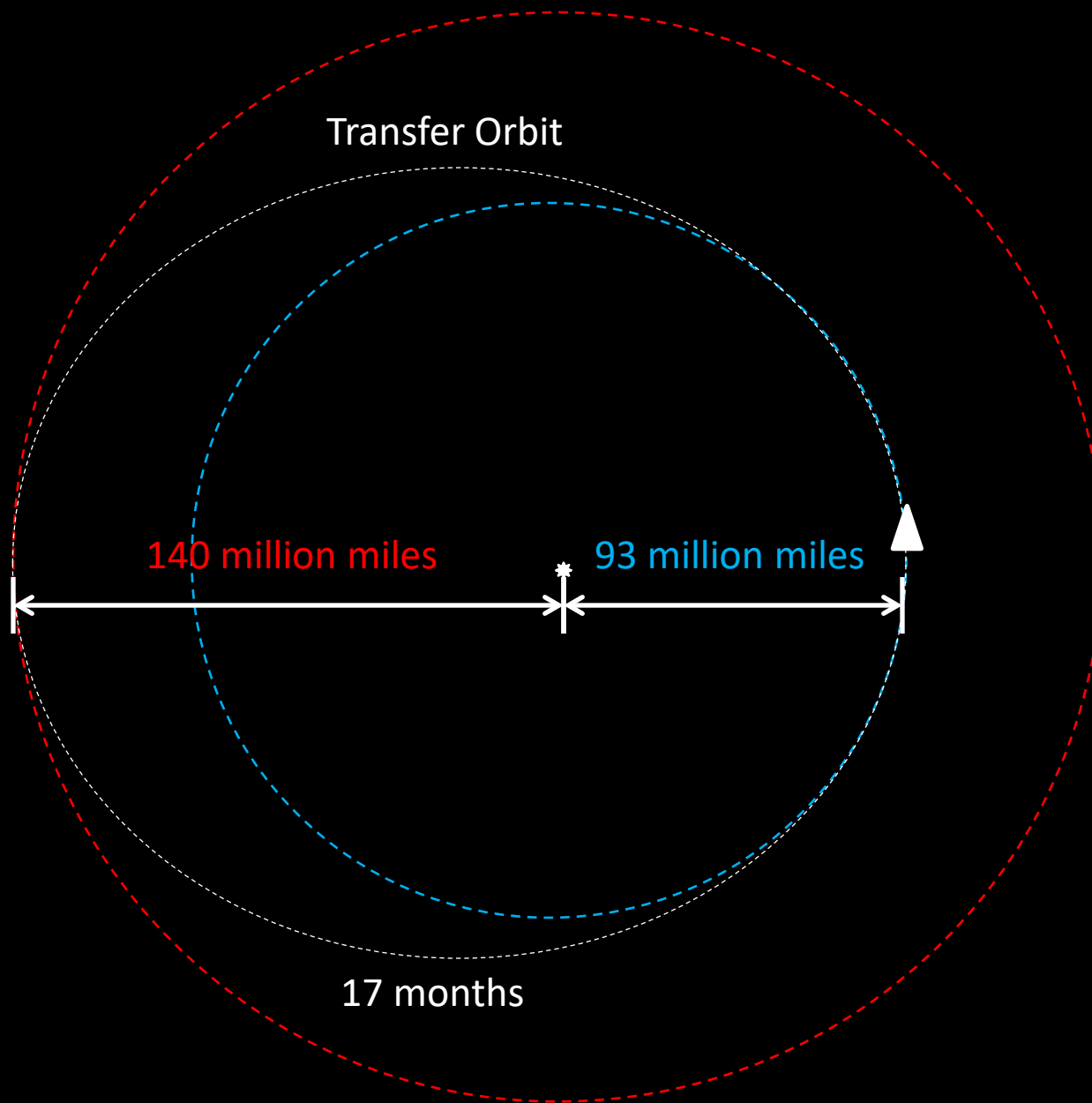
1,000,000 ×



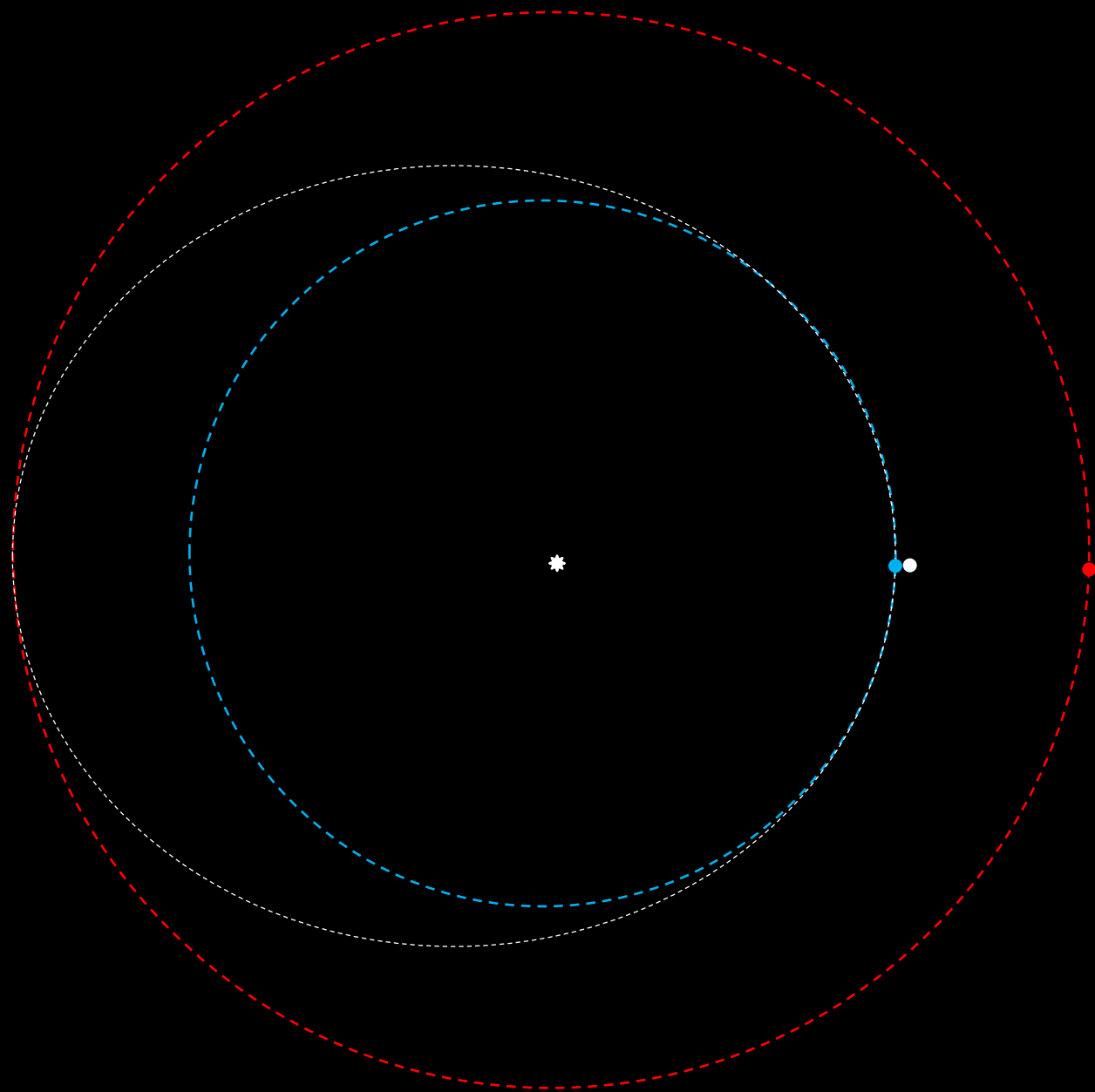


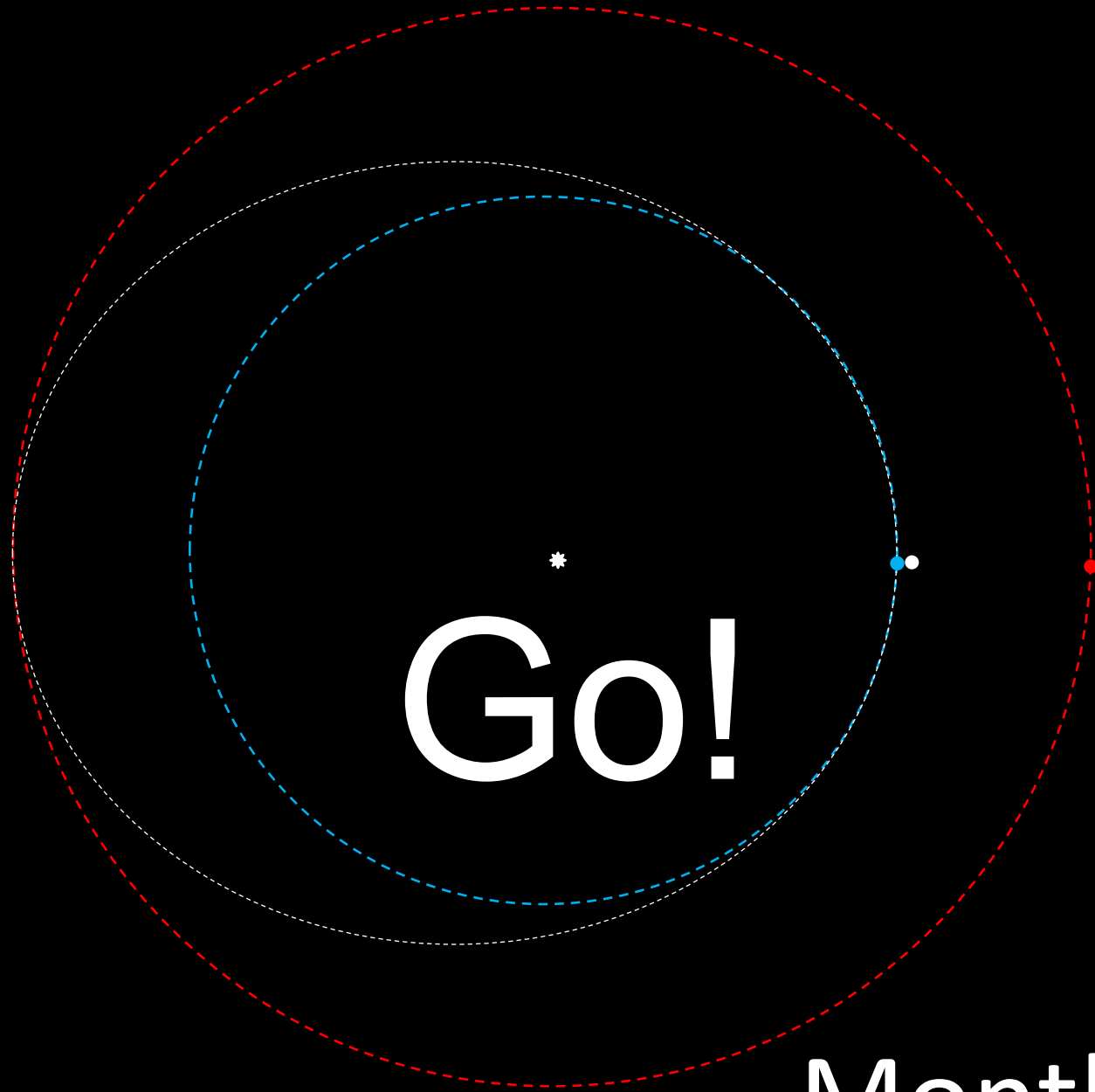
250,000+ mph



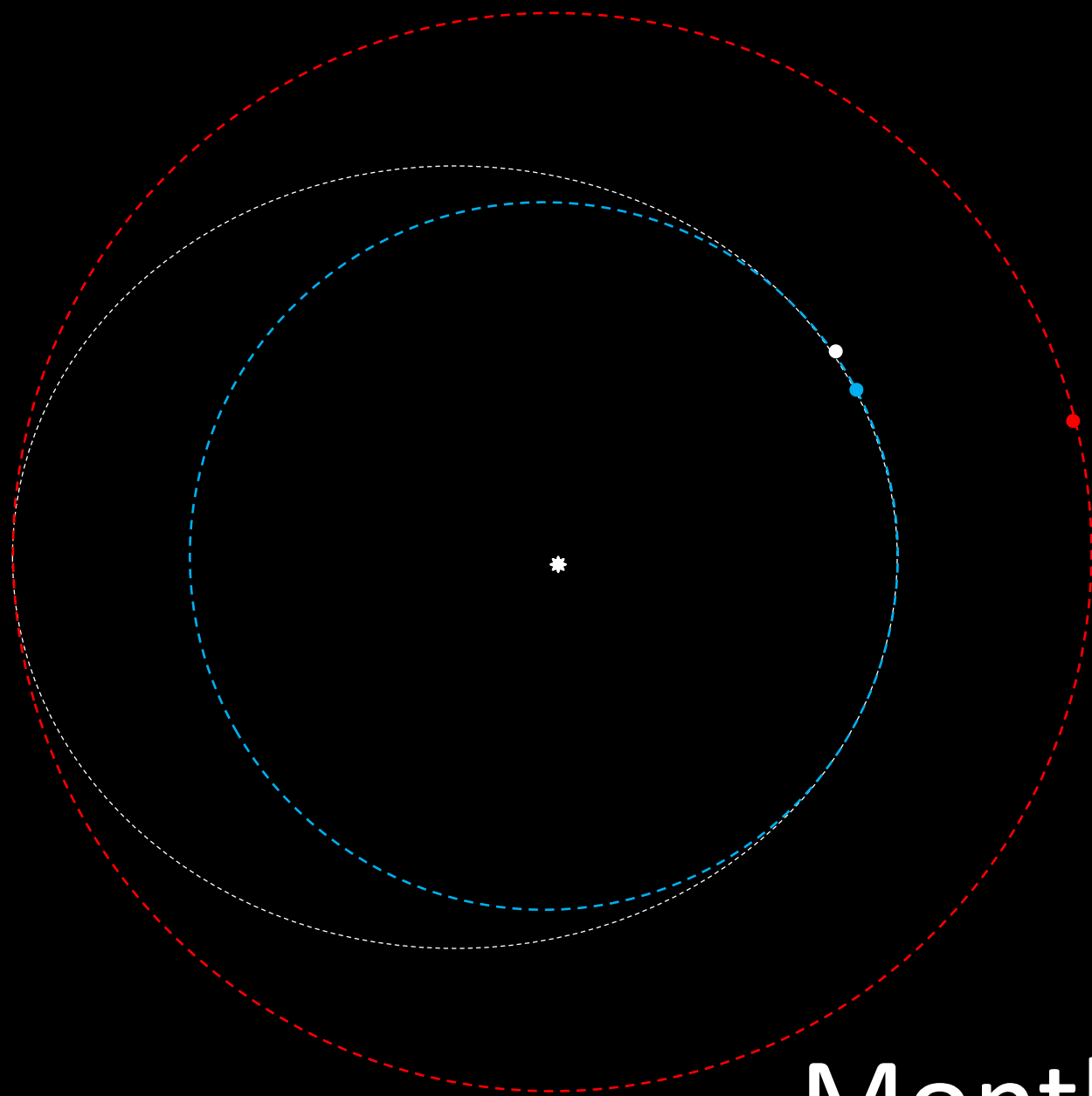




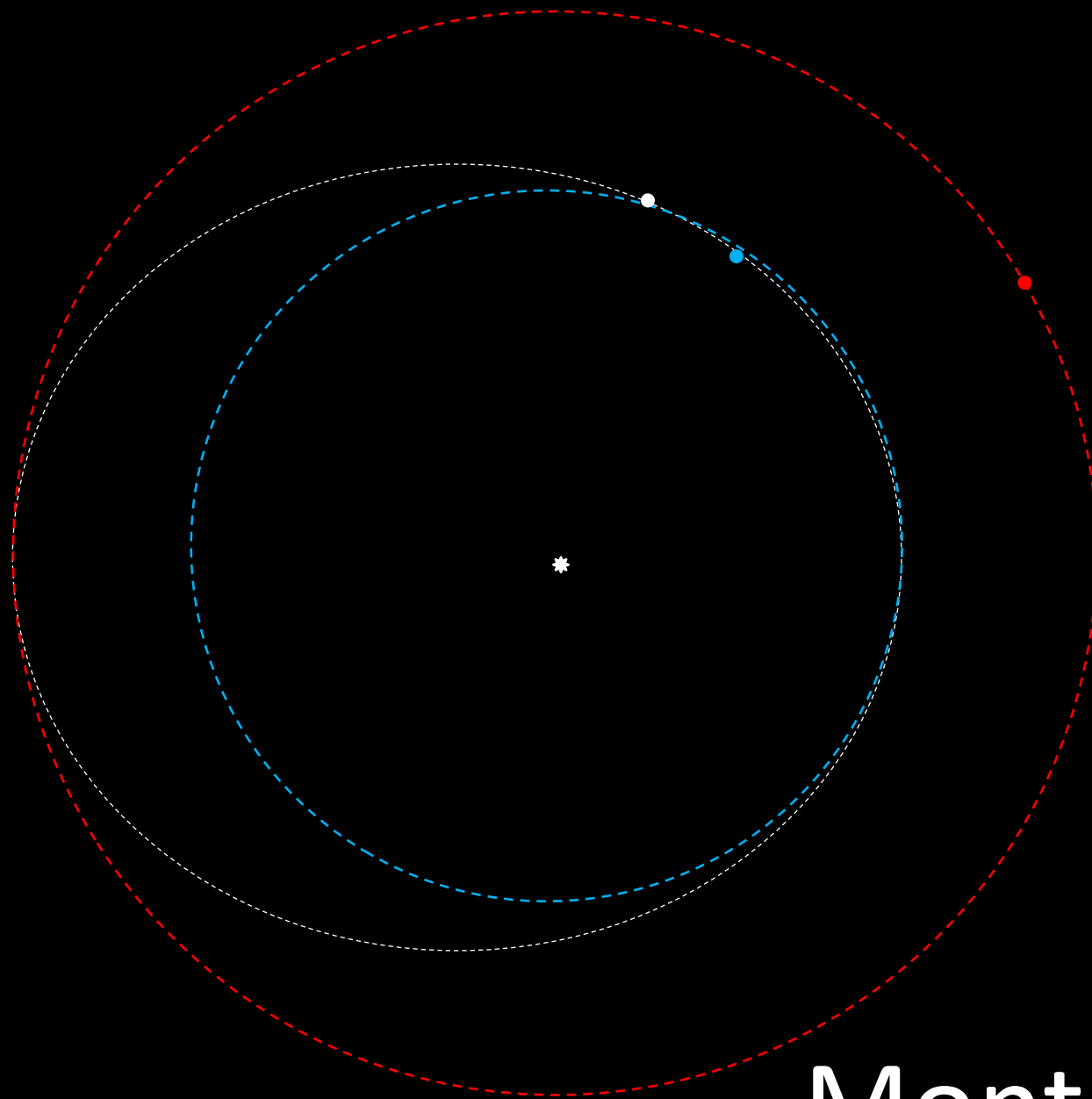




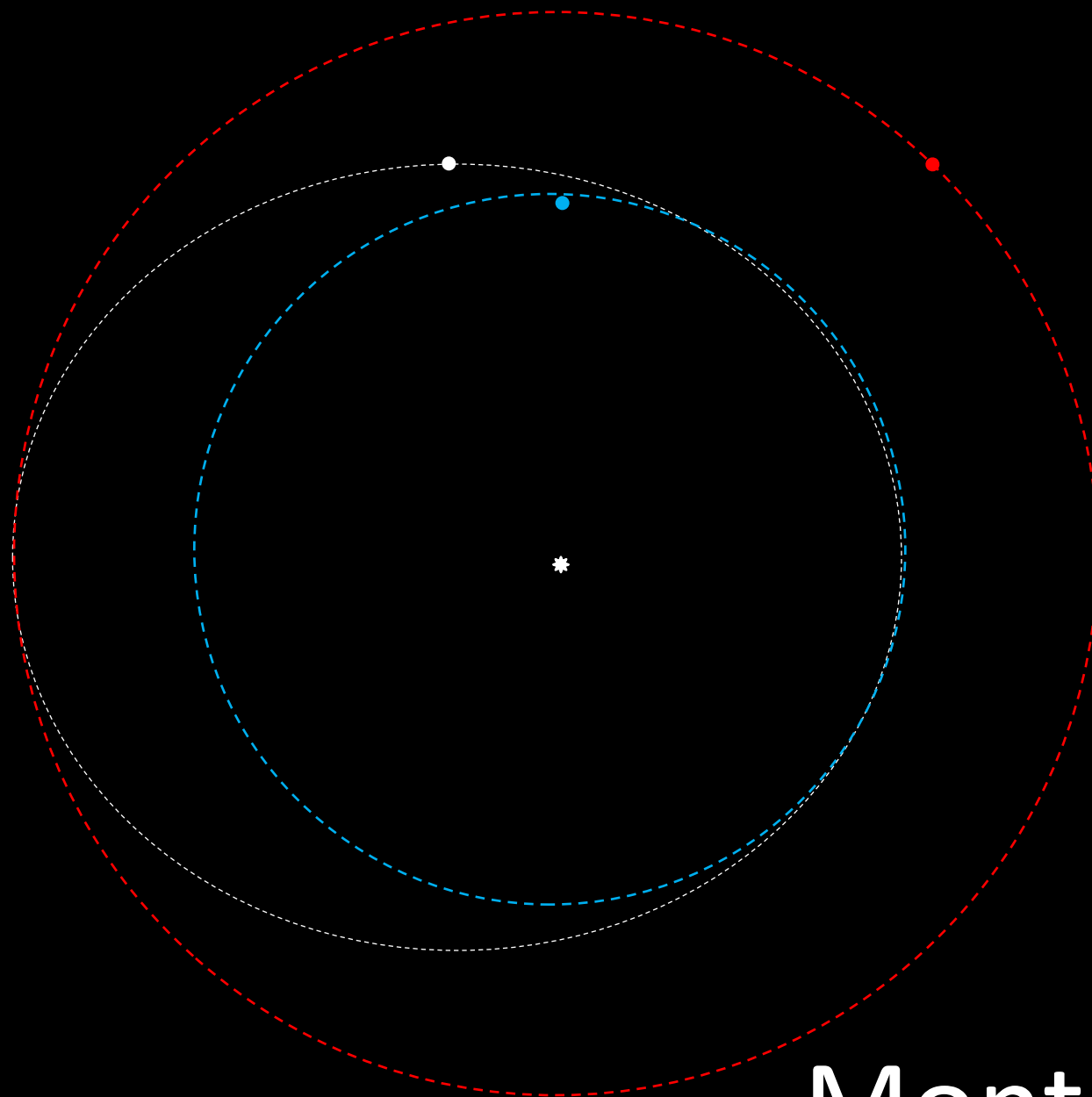
Month 0



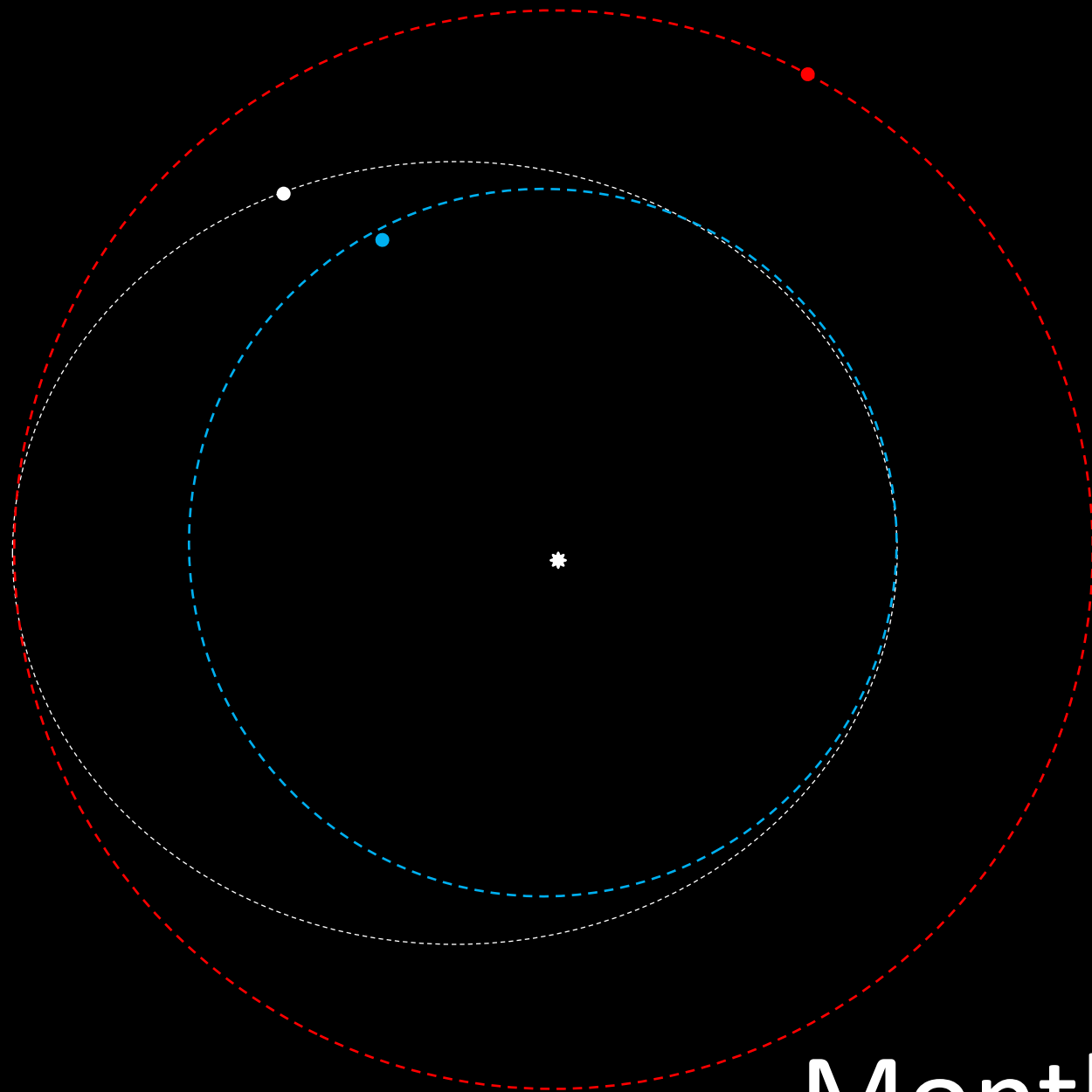
Month 1



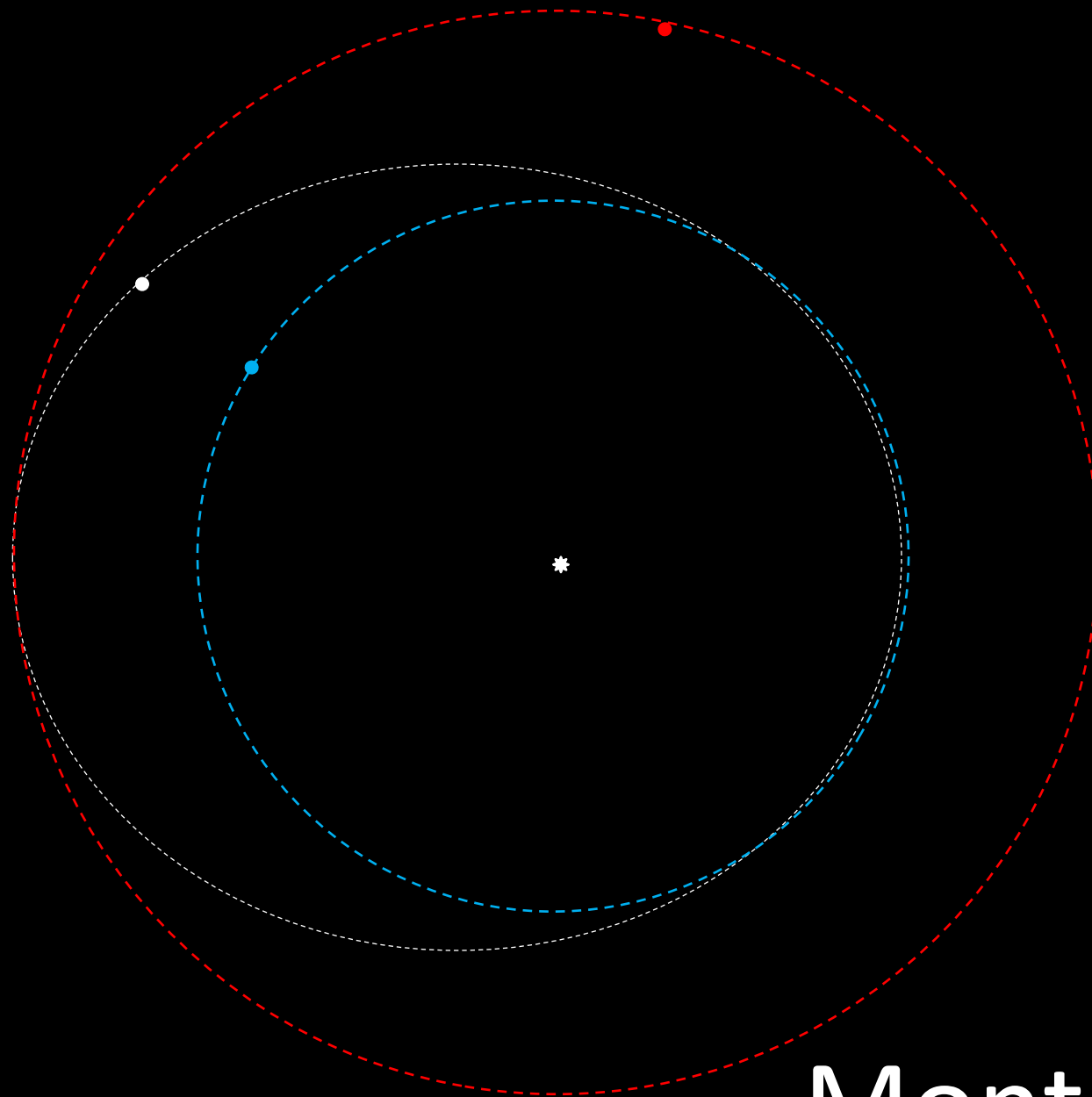
Month 2



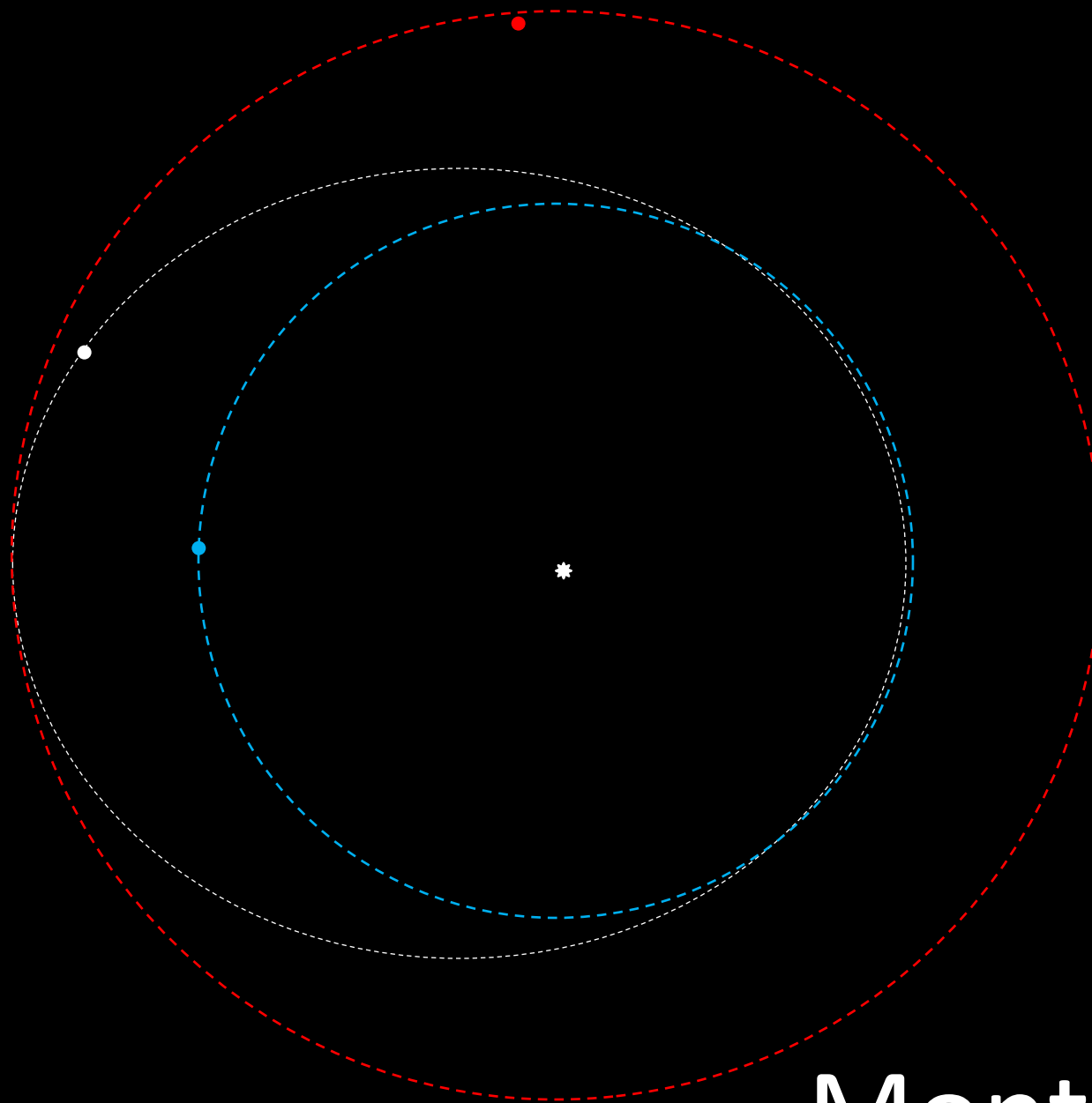
Month 3



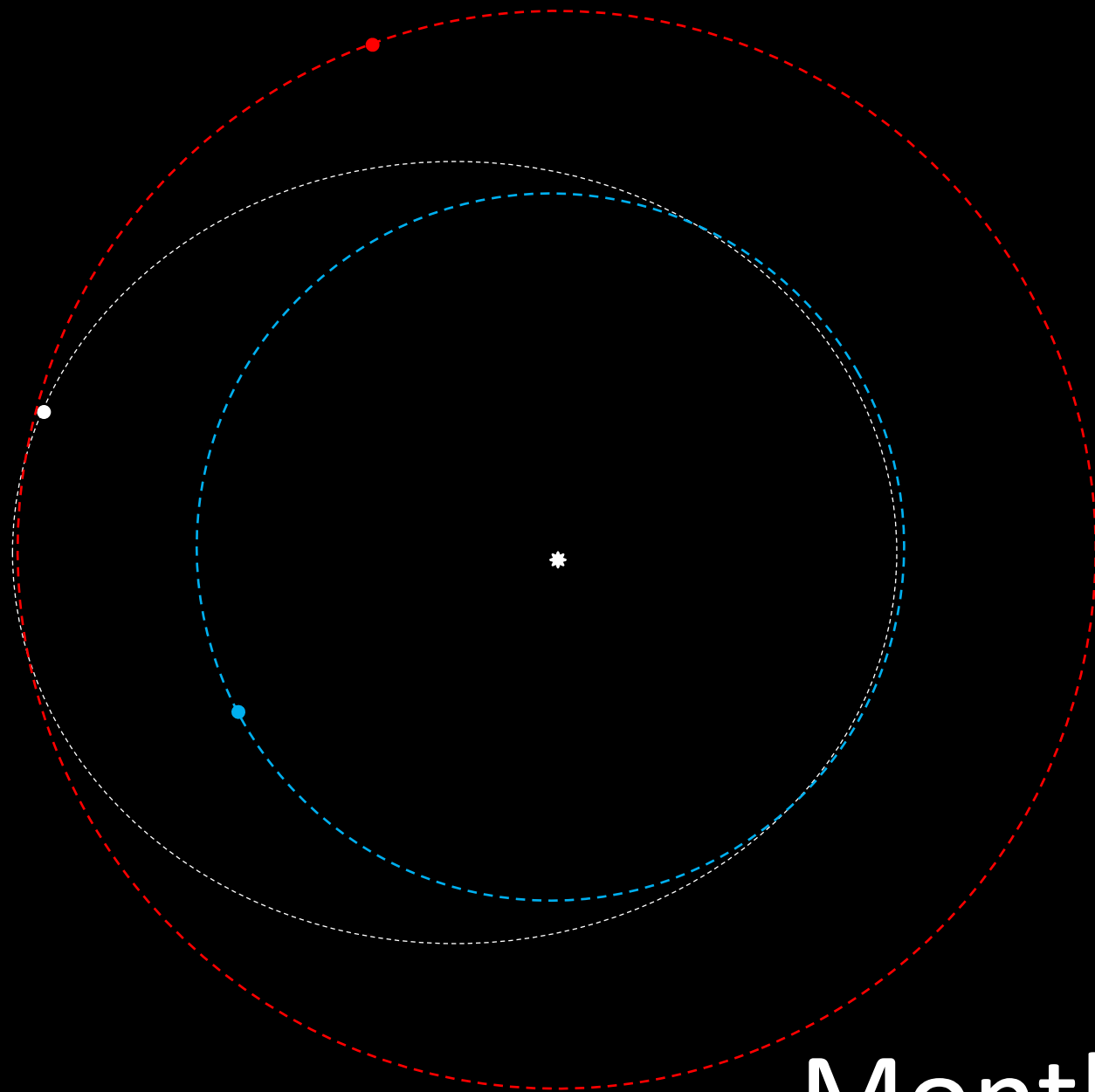
Month 4



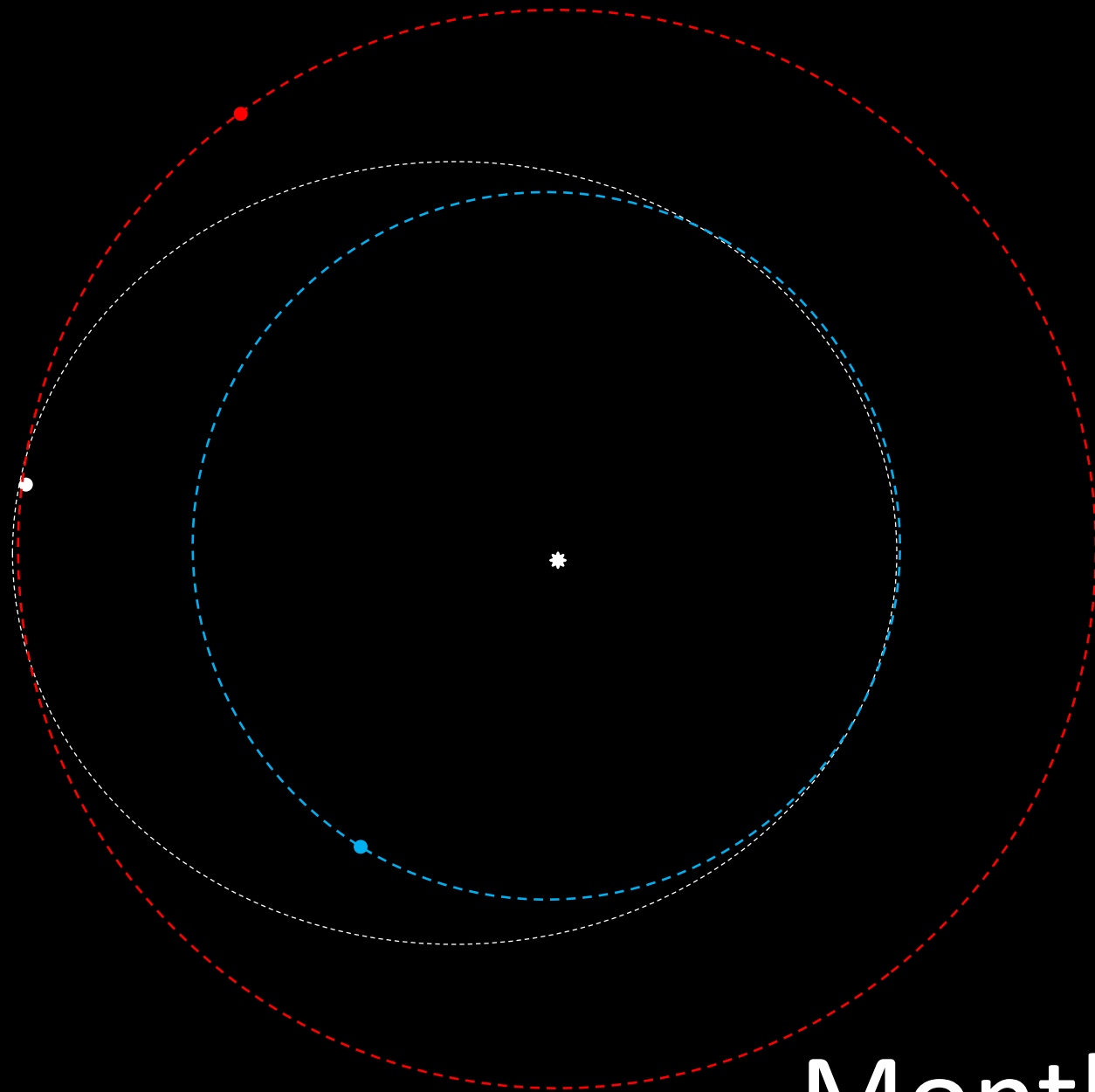
Month 5



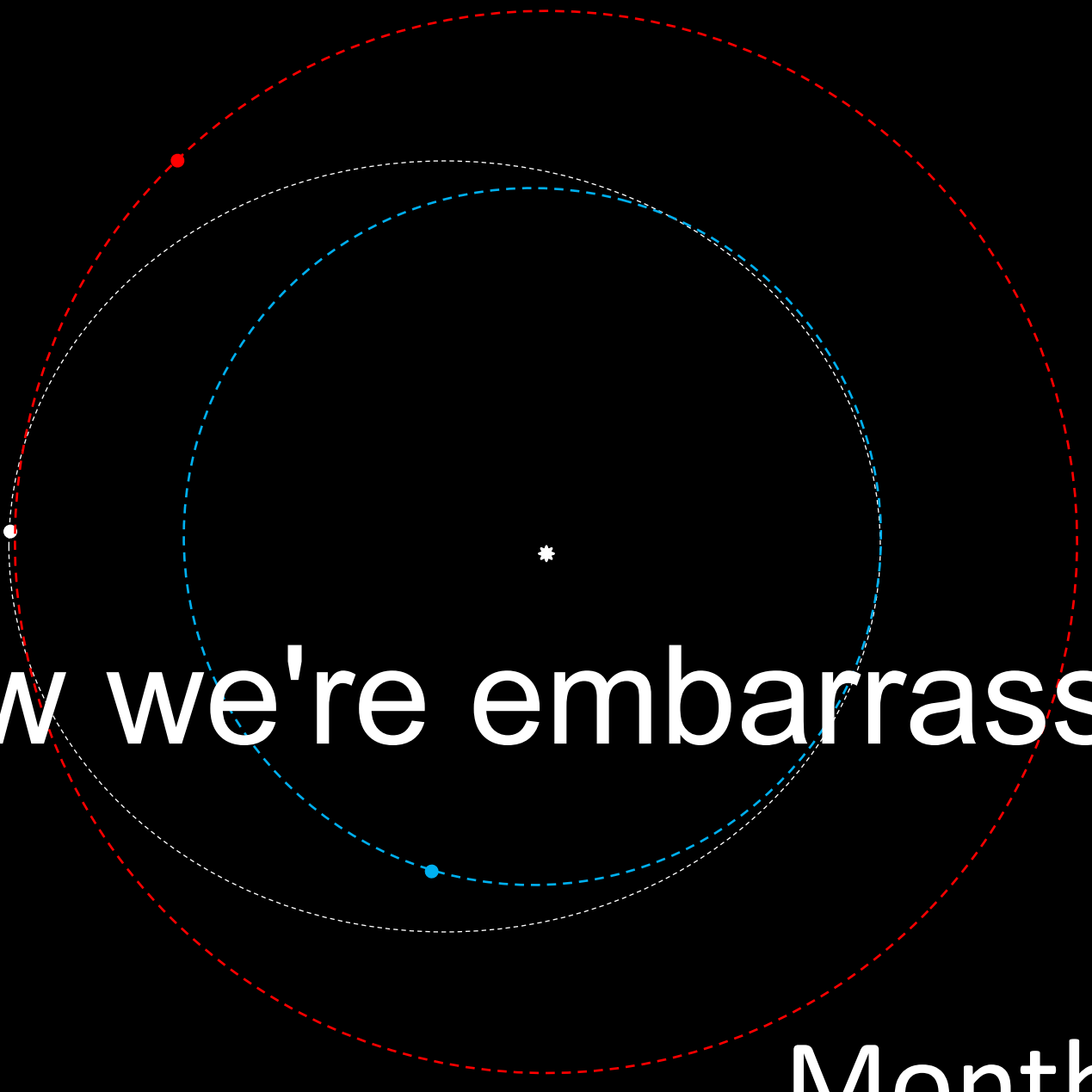
Month 6



Month 7

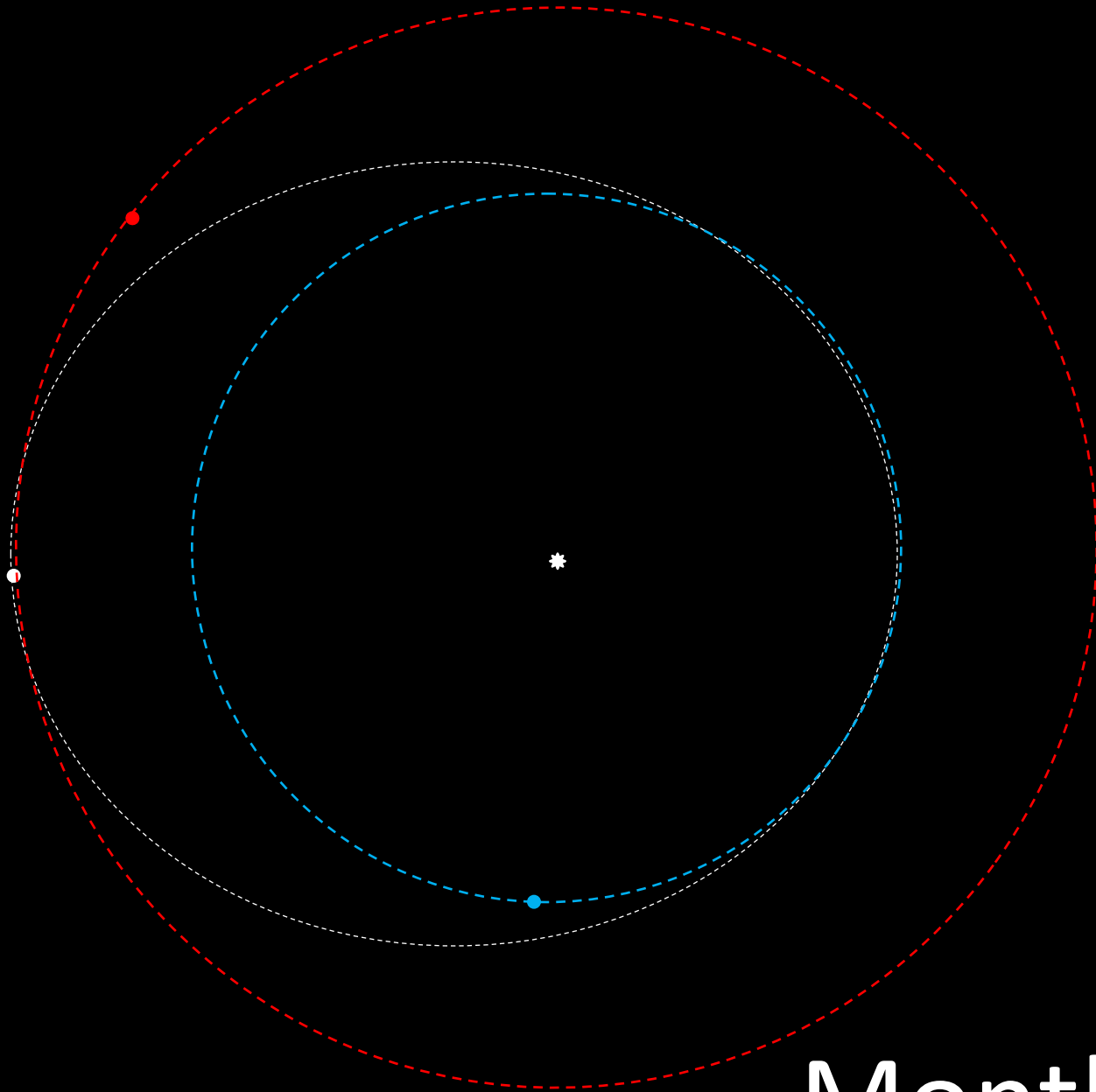


Month 8

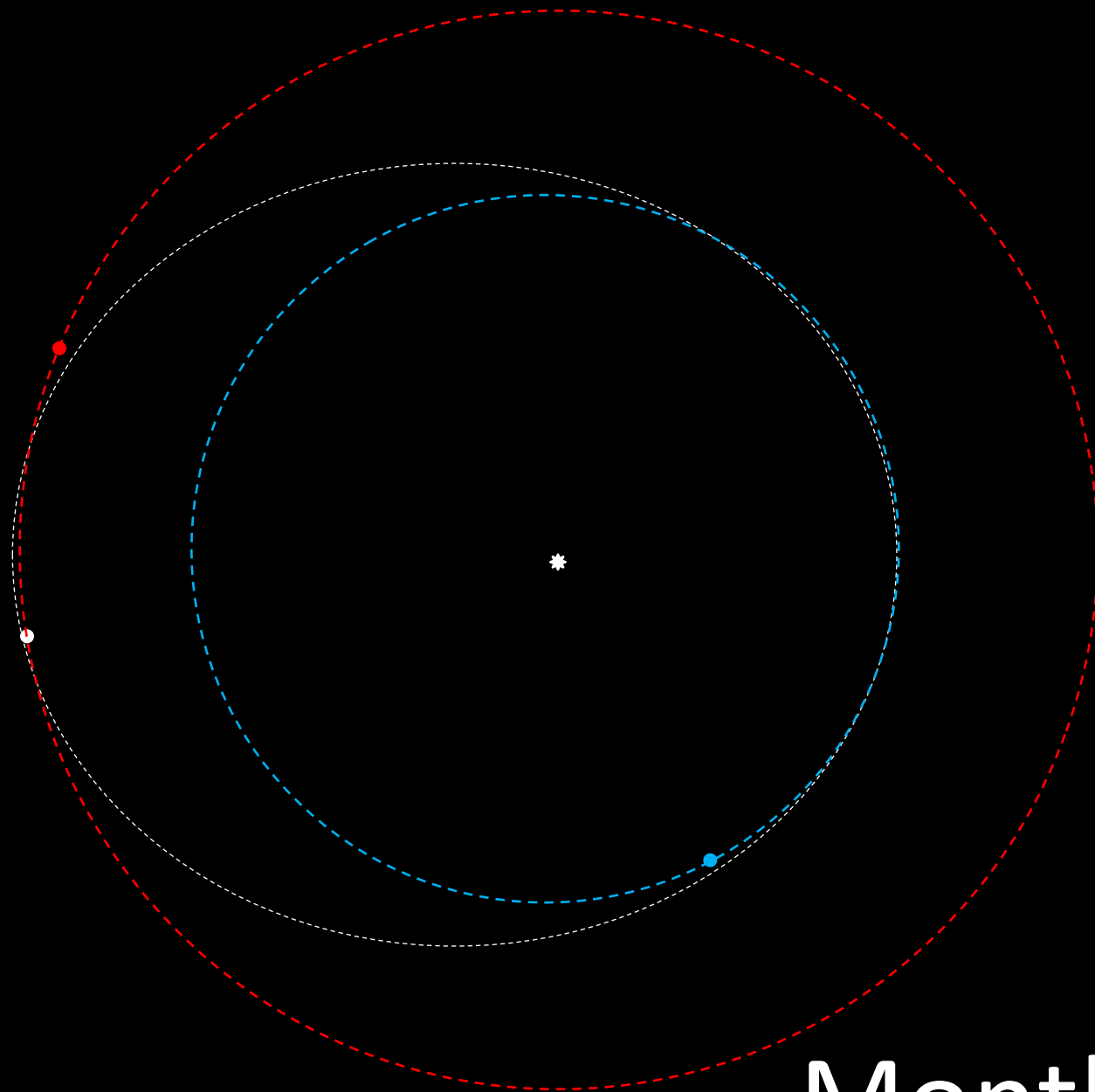


Now we're embarrassed.

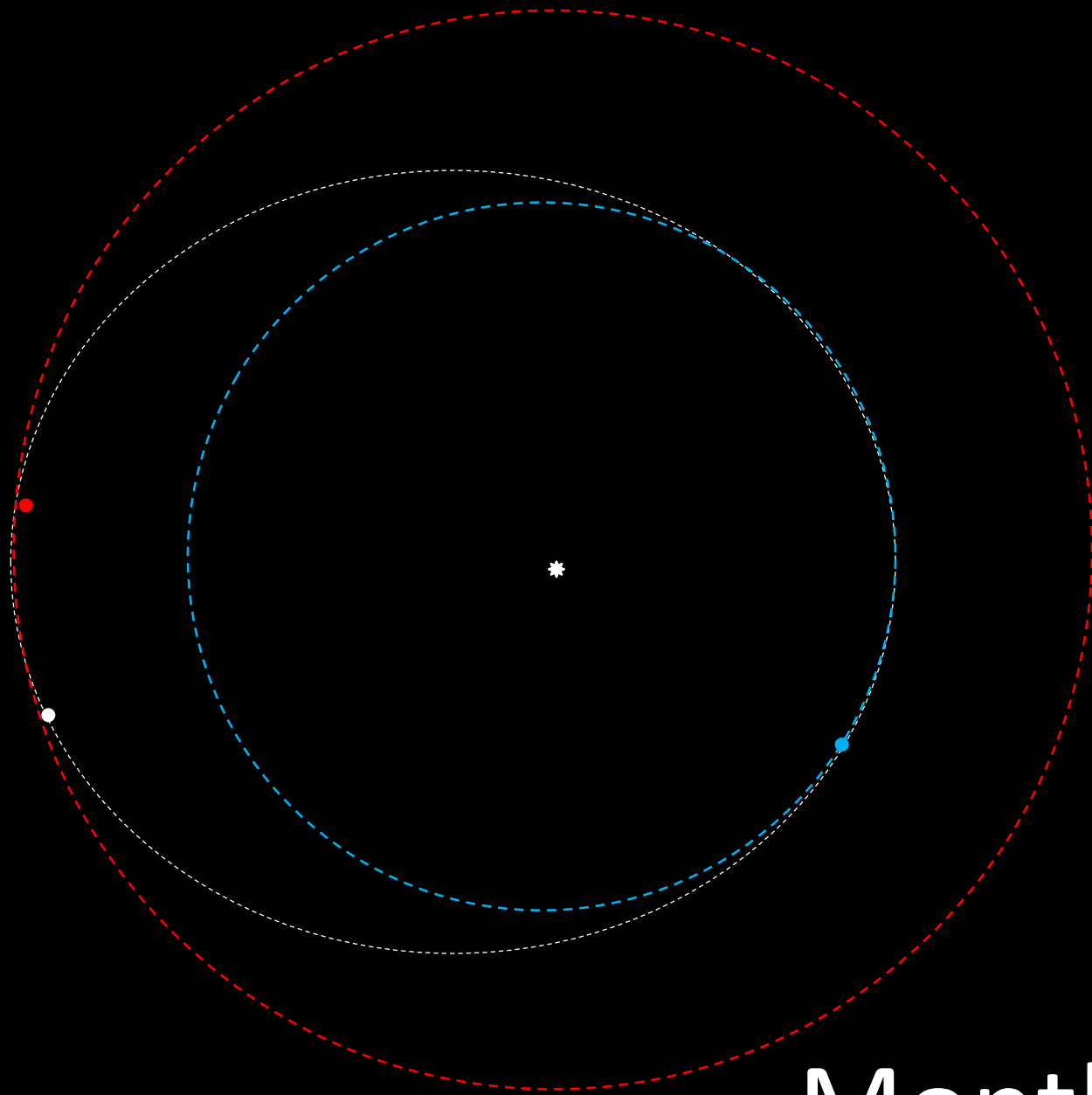
Month 8.5



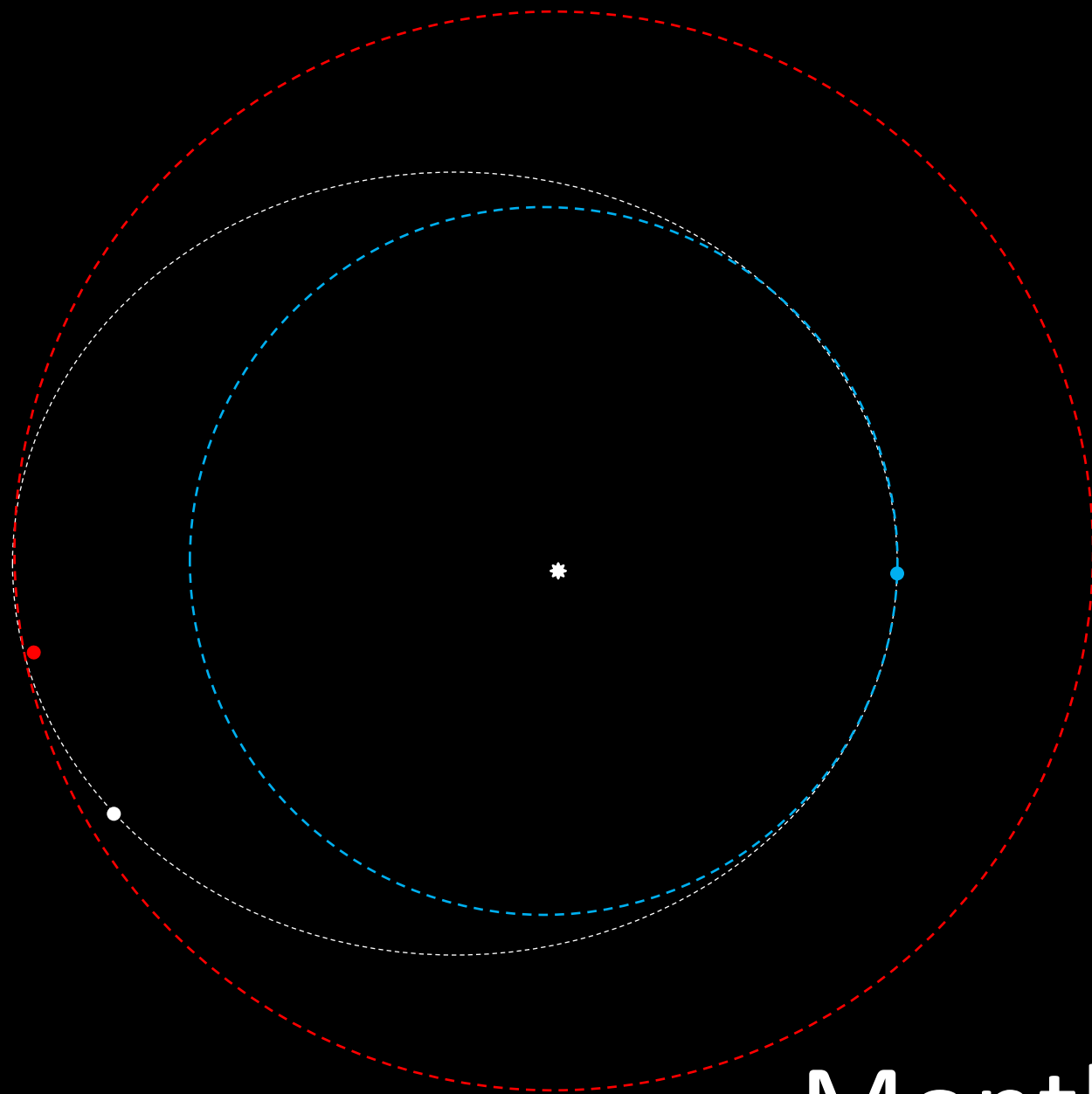
Month 9



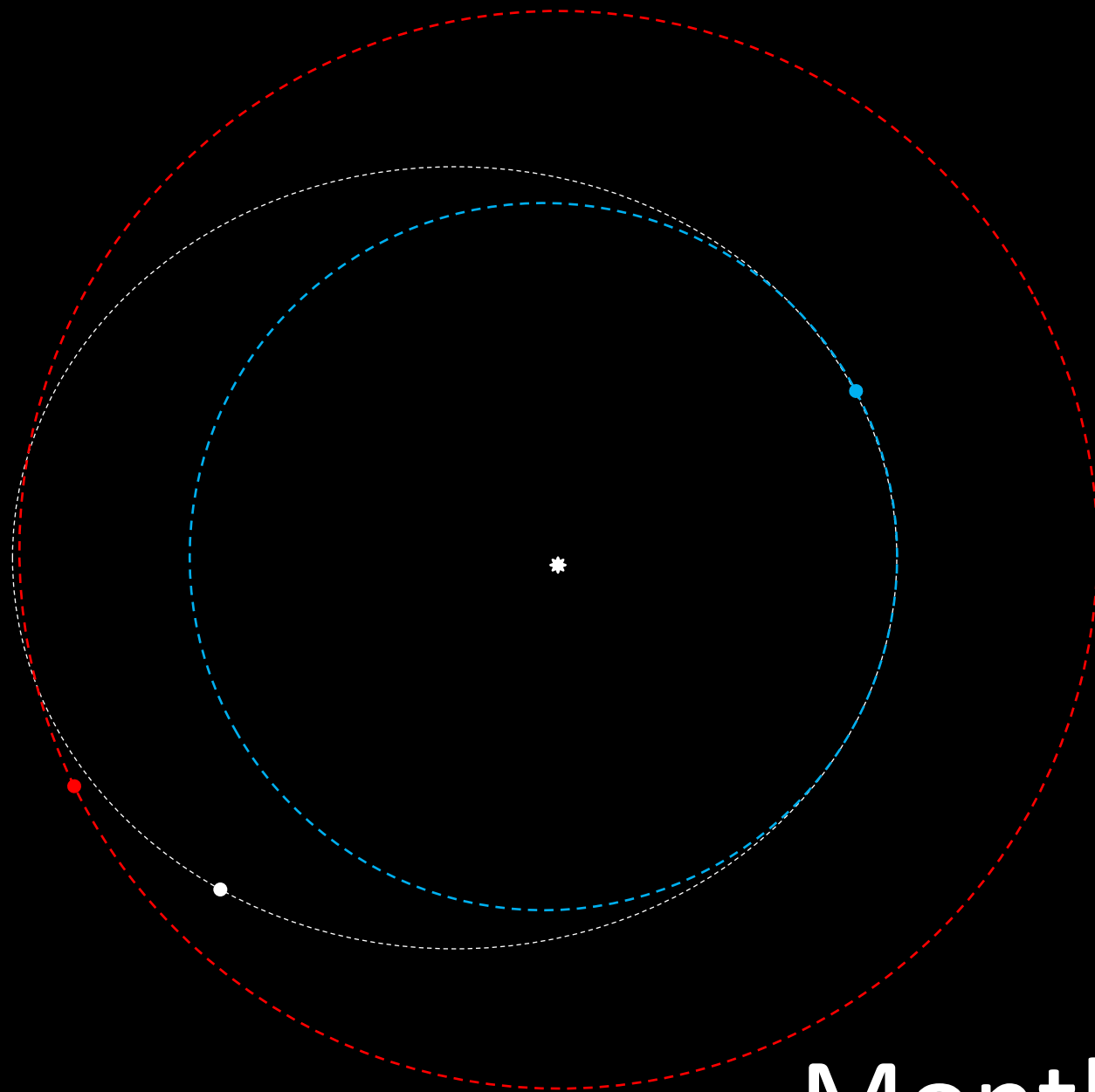
Month 10



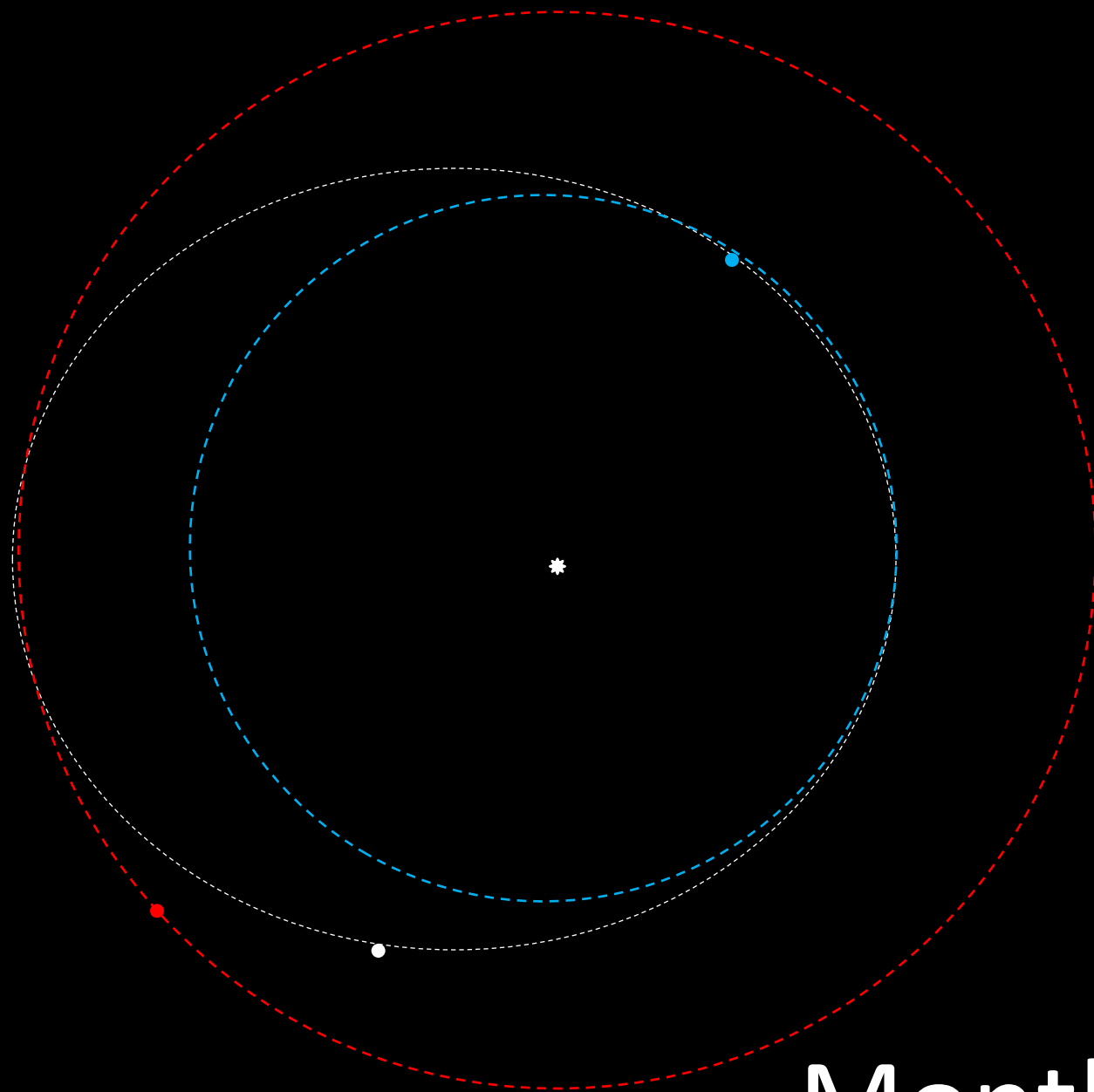
Month 11



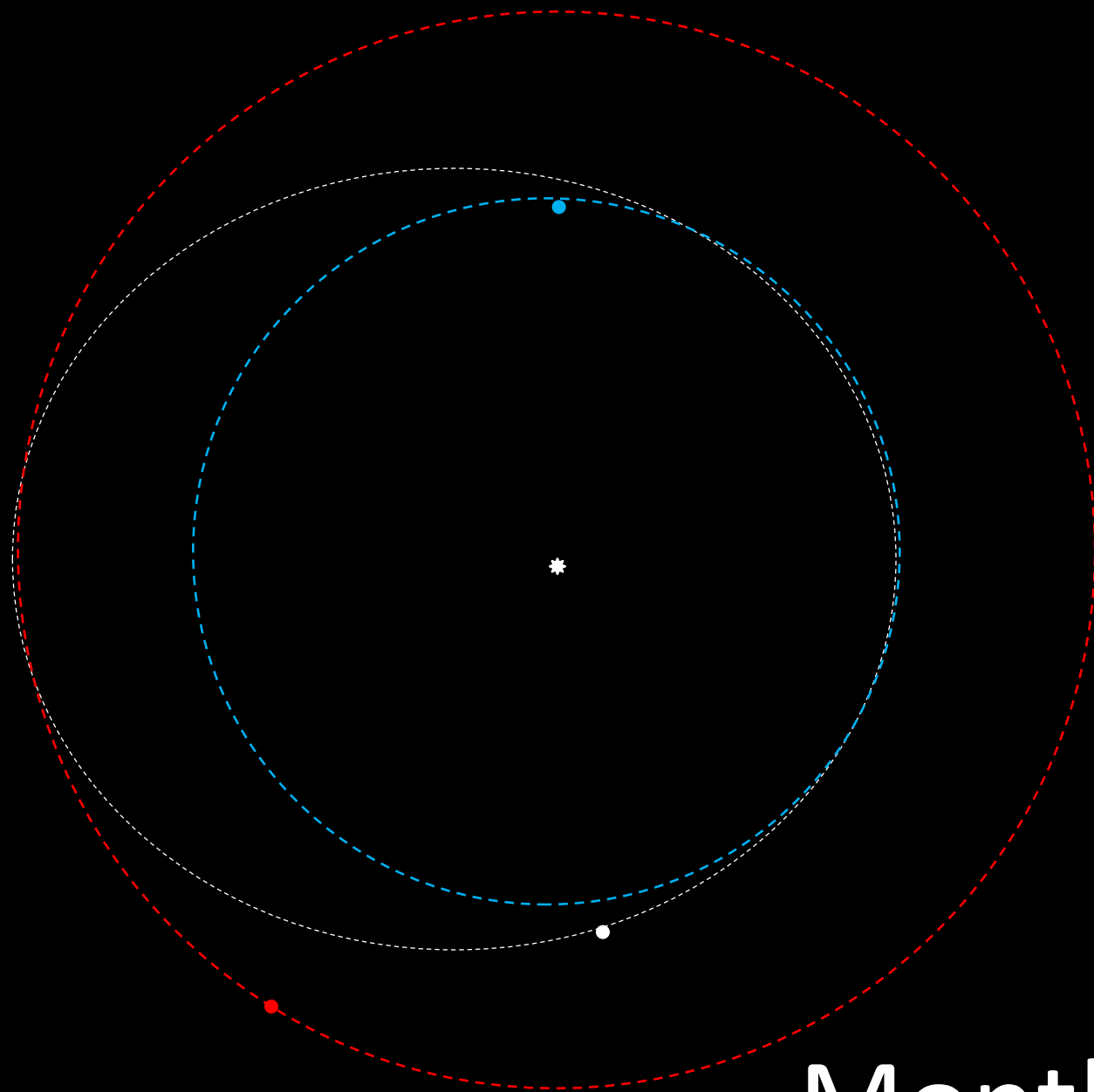
Month 12



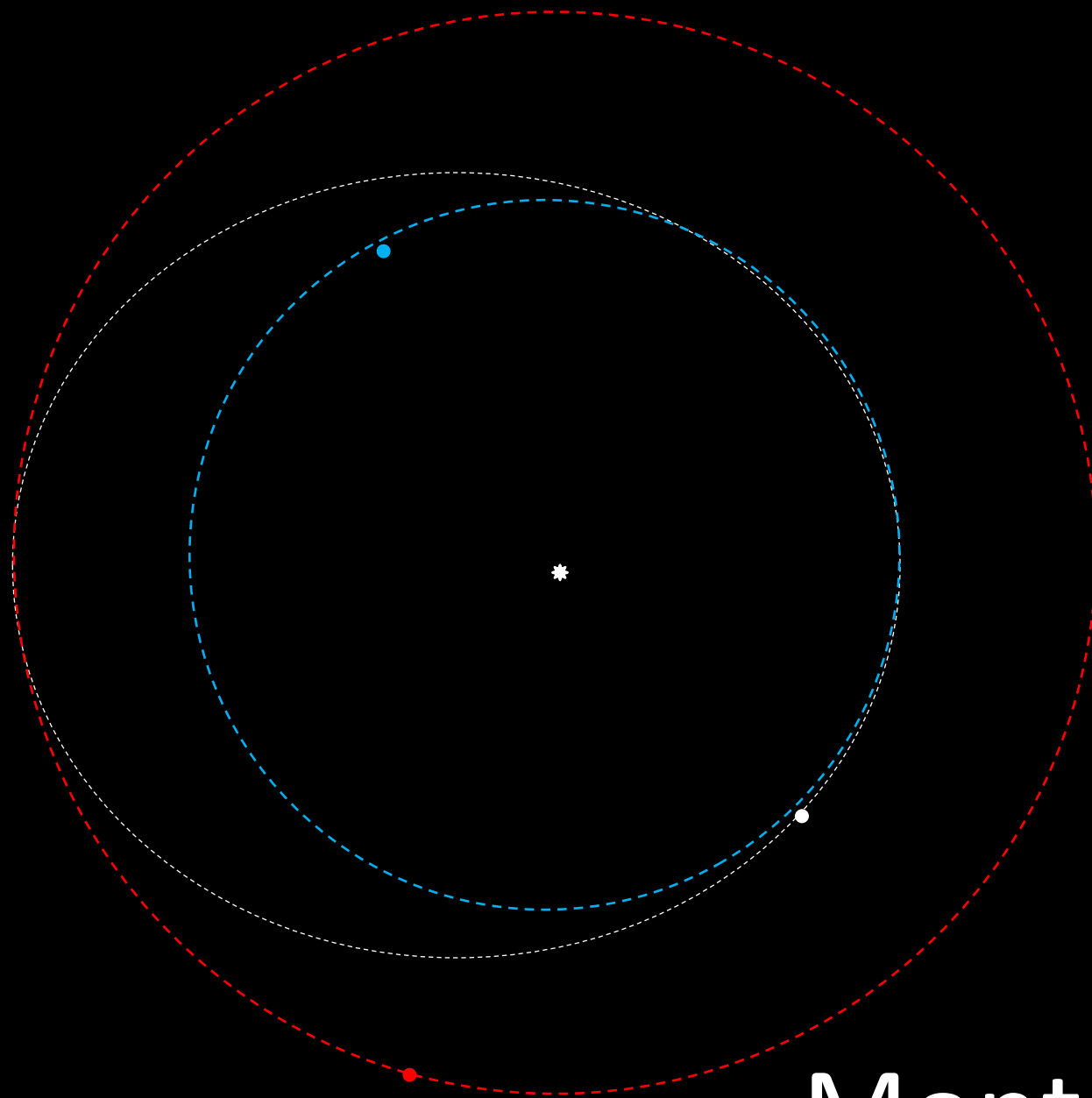
Month 13



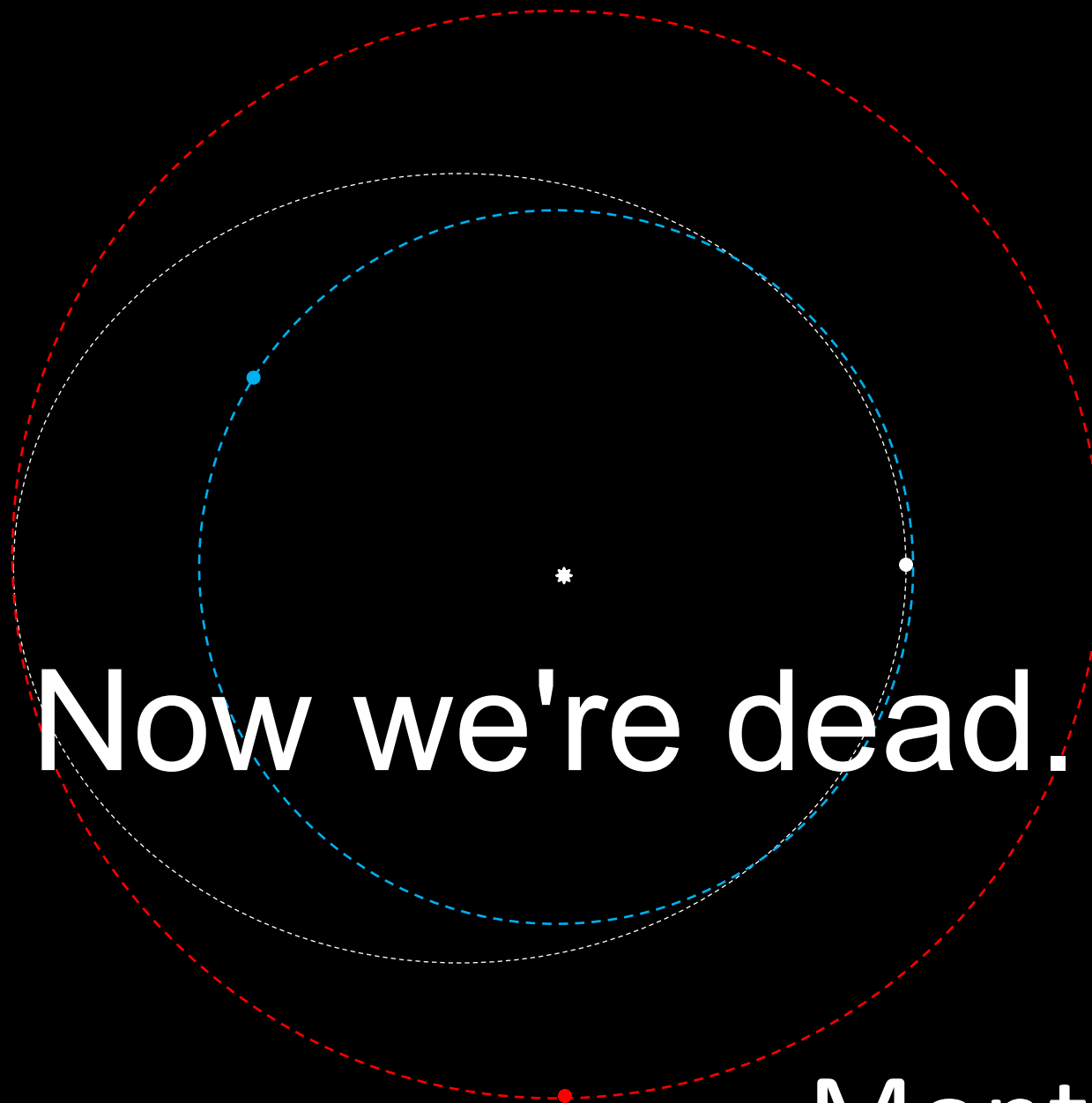
Month 14



Month 15

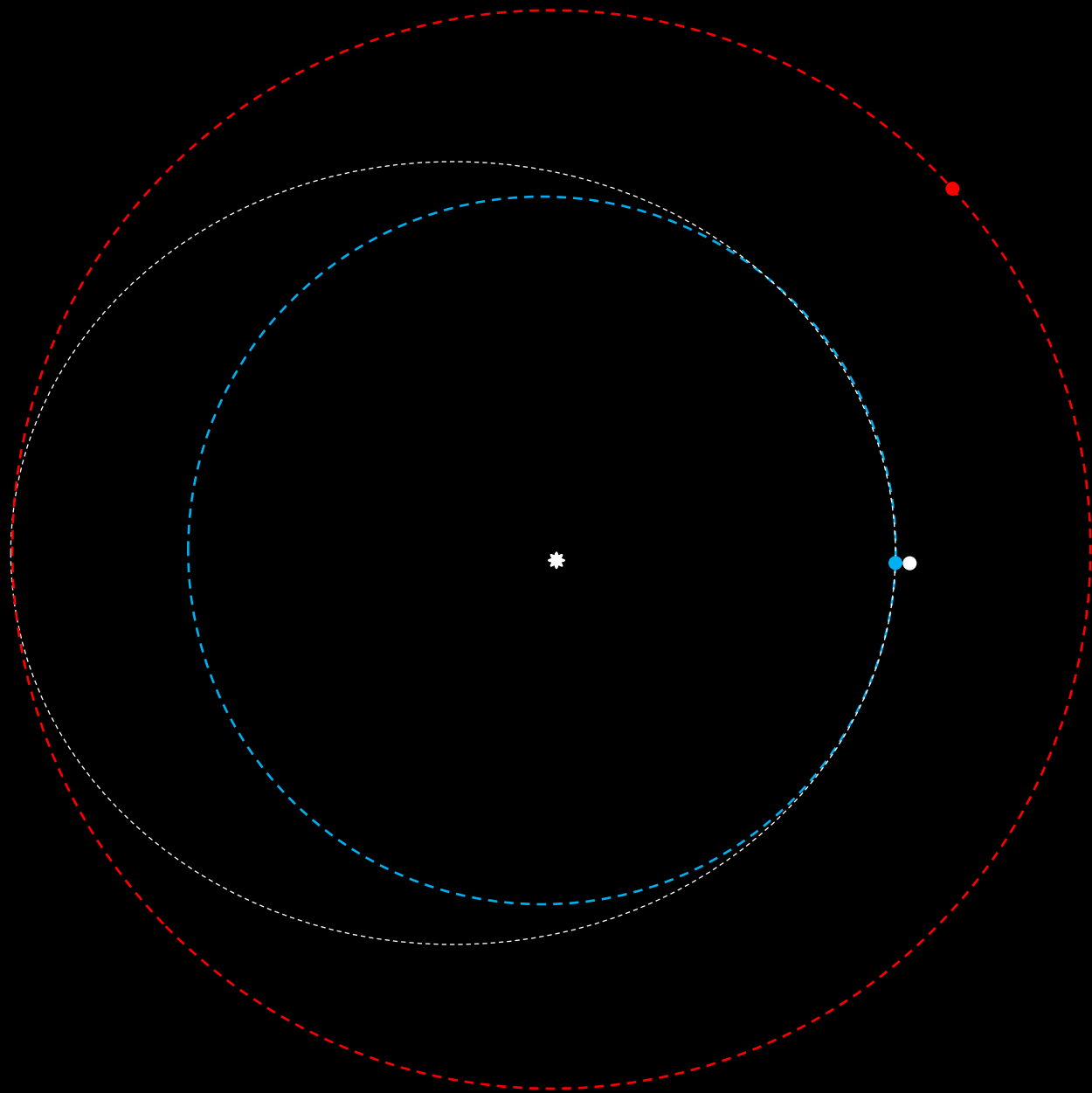


Month 16



Now we're dead.

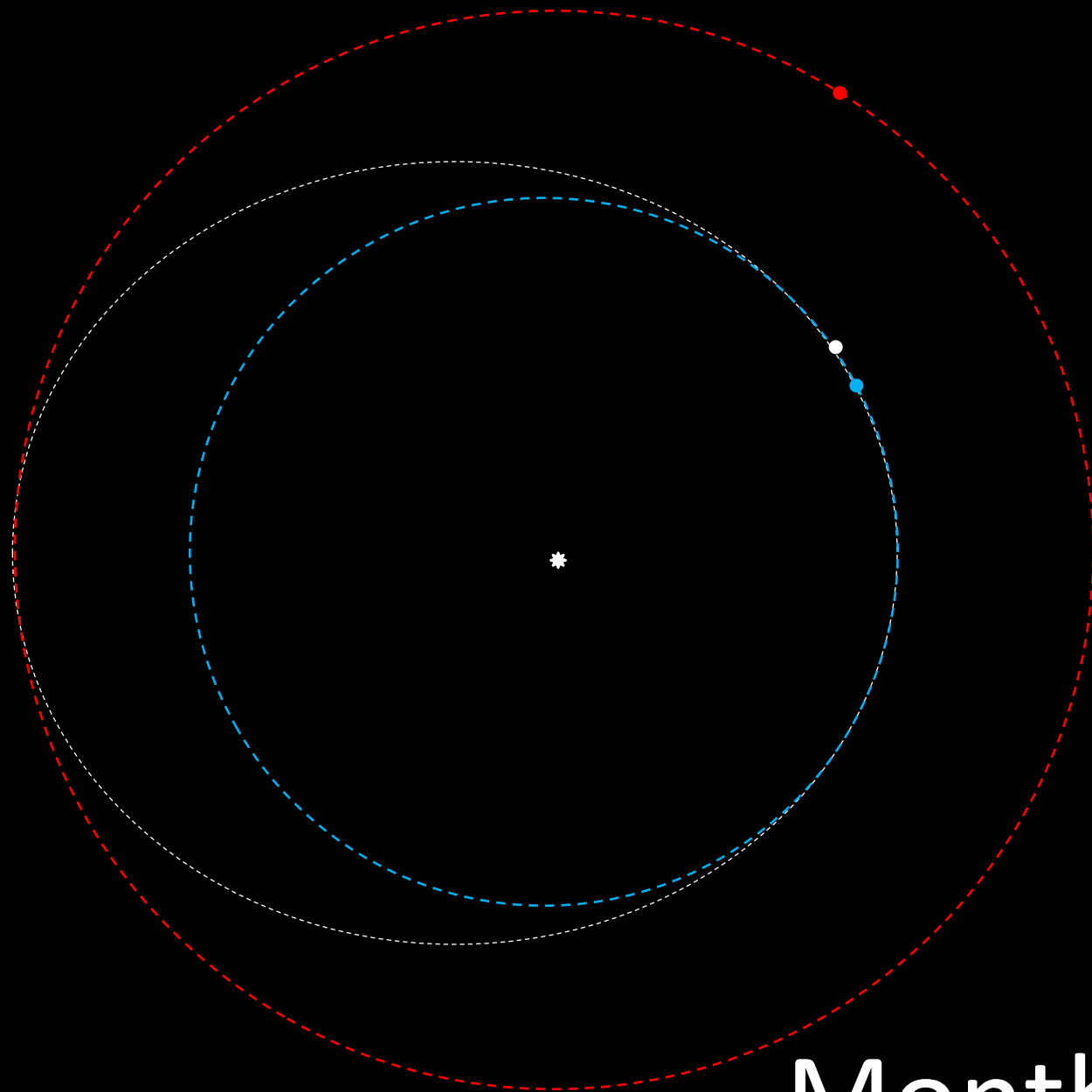
Month 17



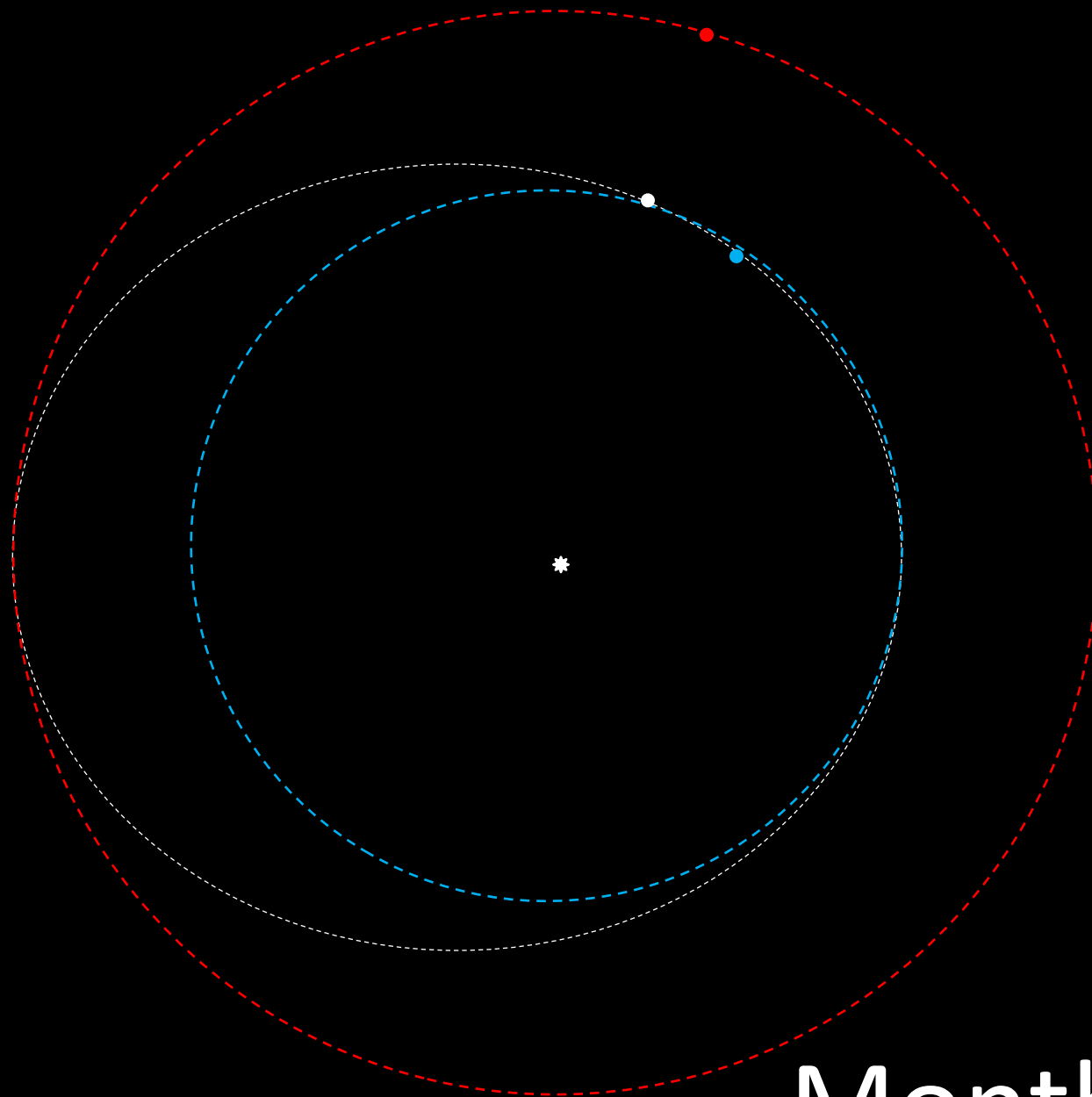


Go!

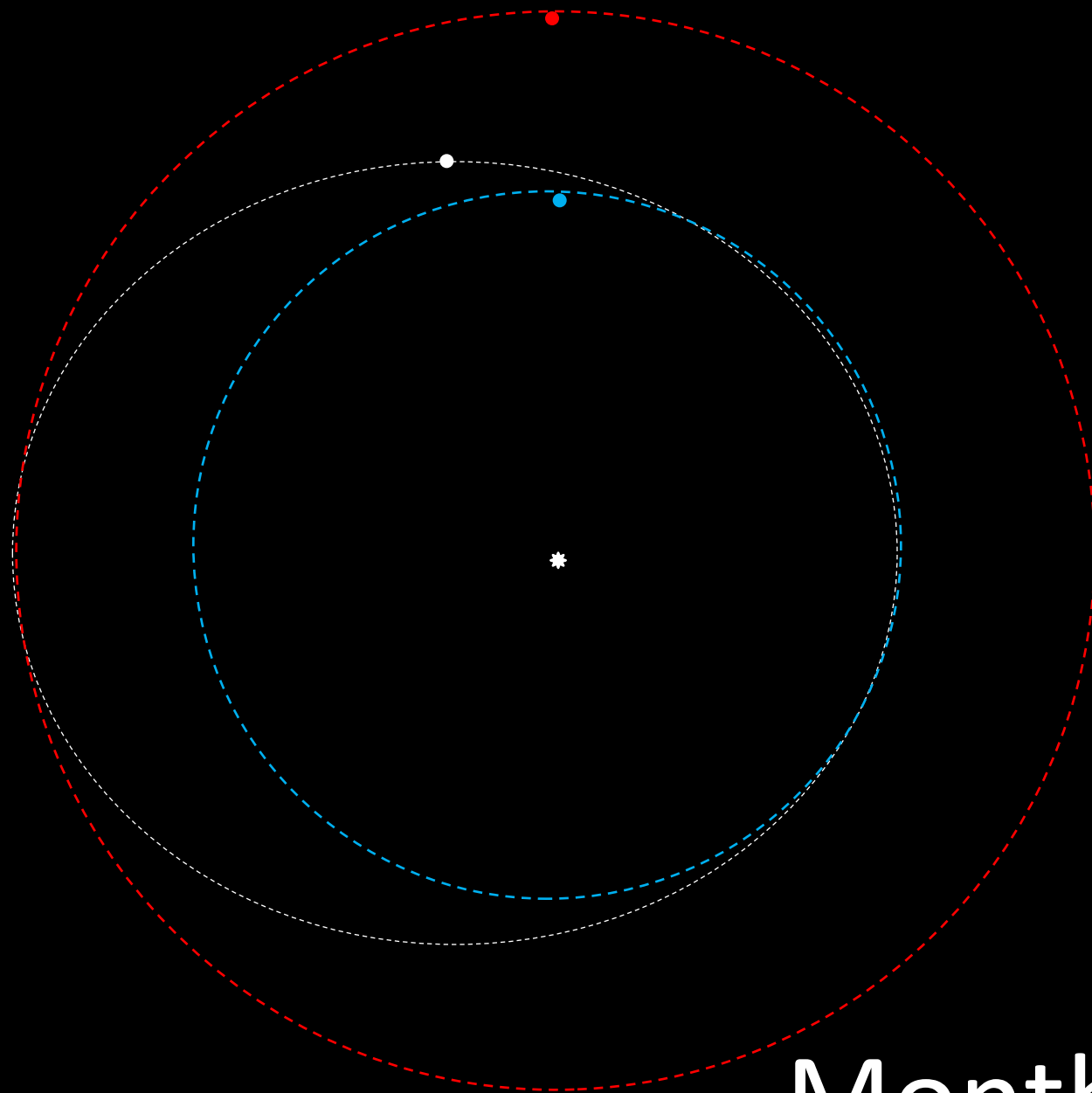
Month 0



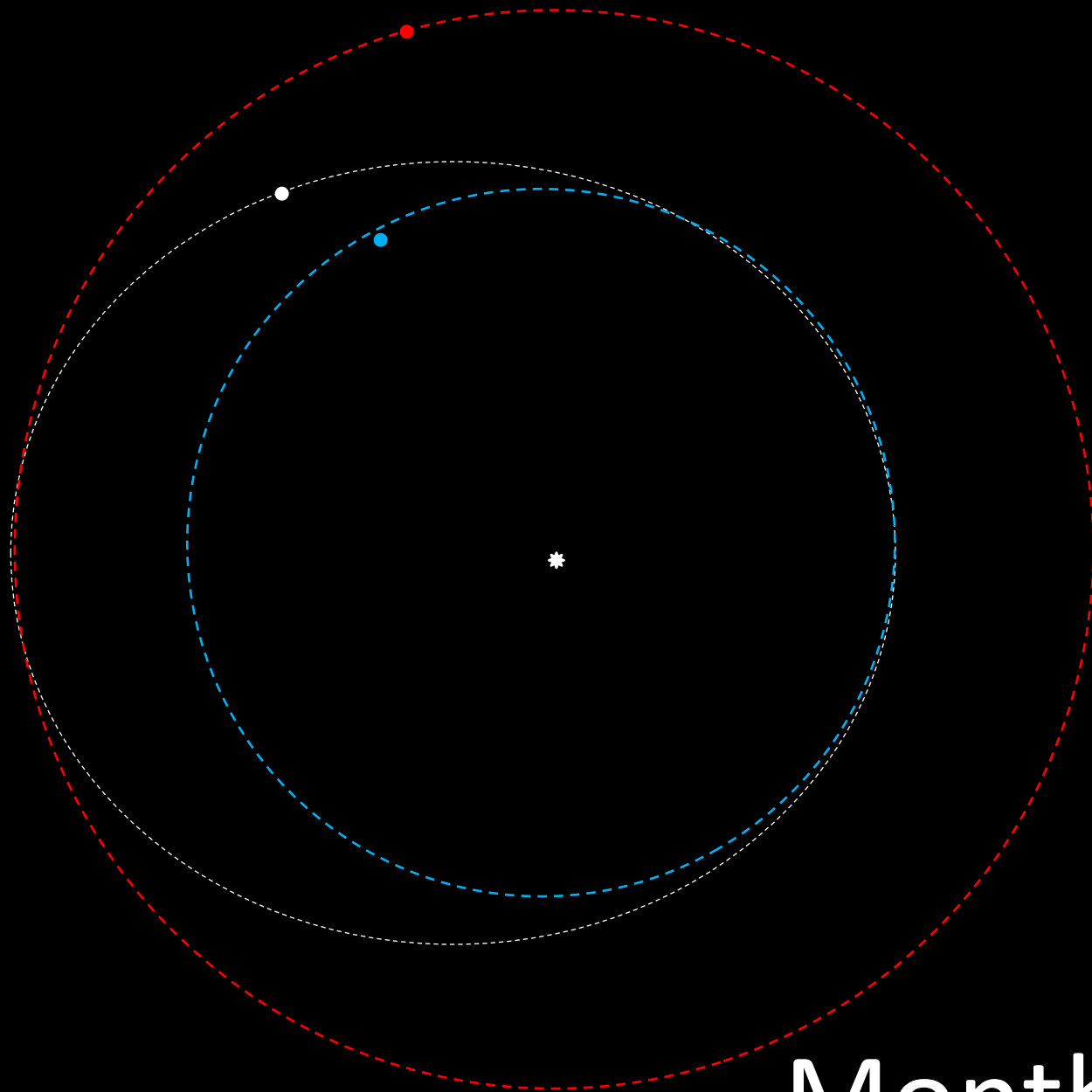
Month 1



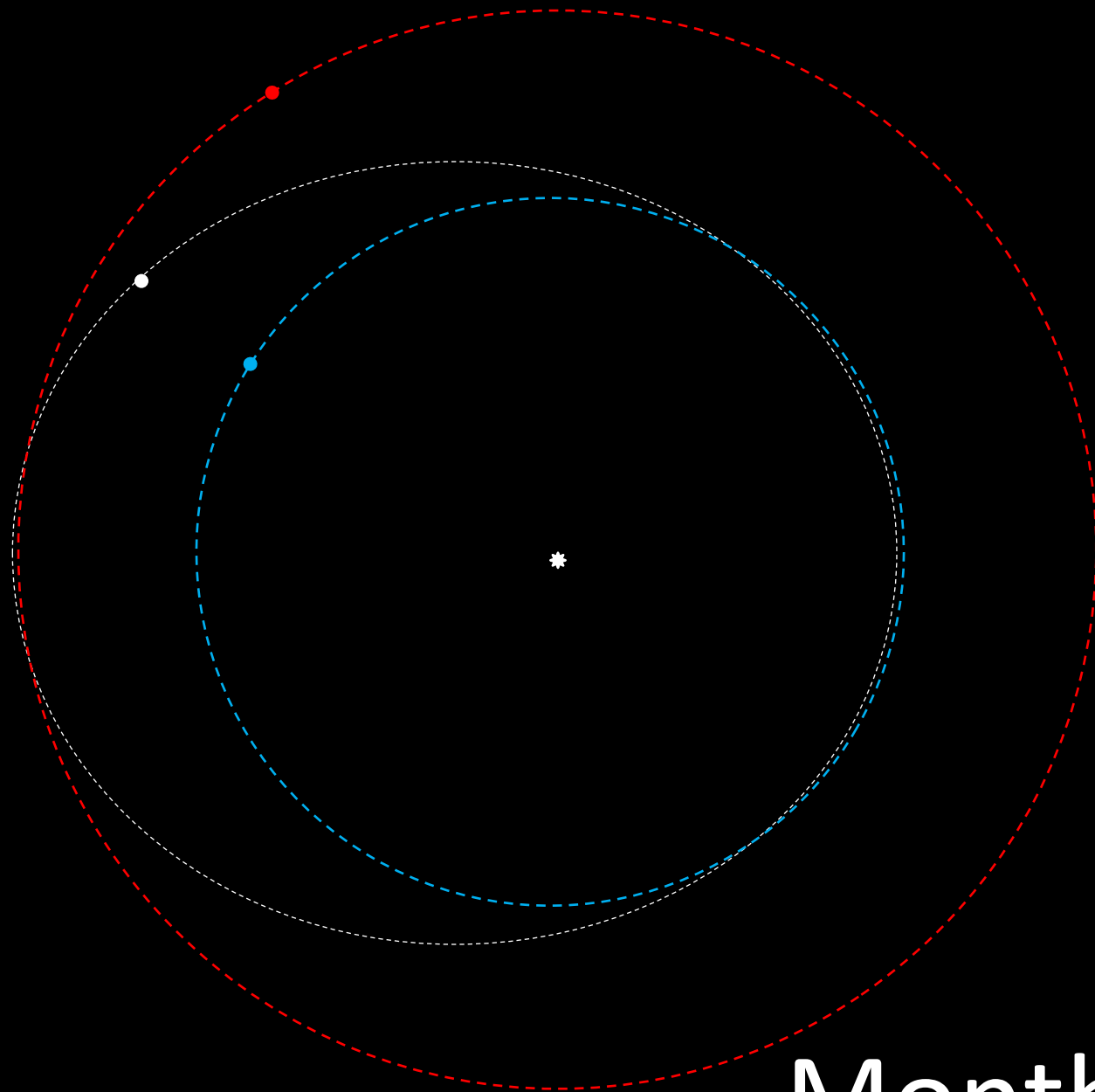
Month 2



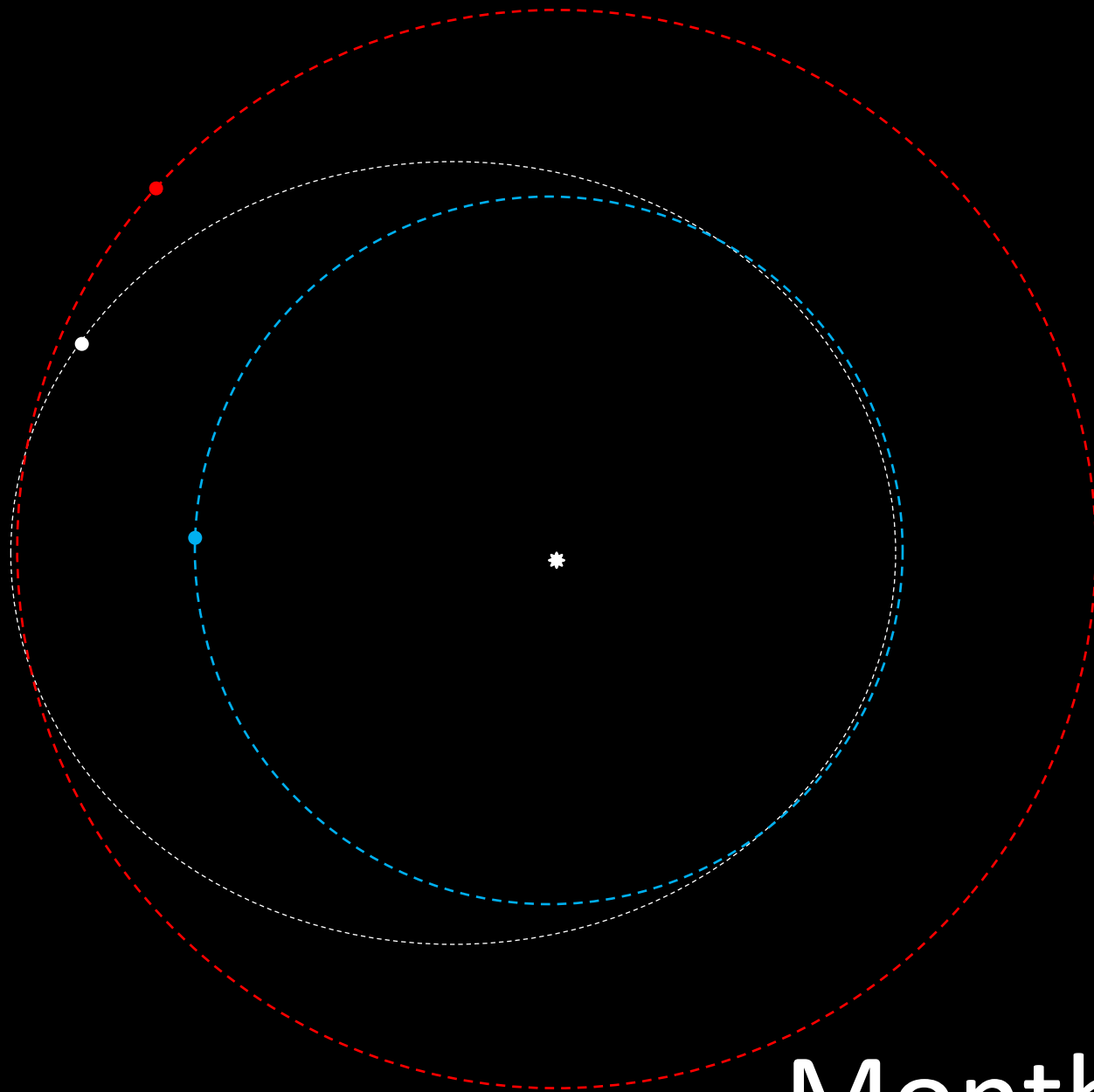
Month 3



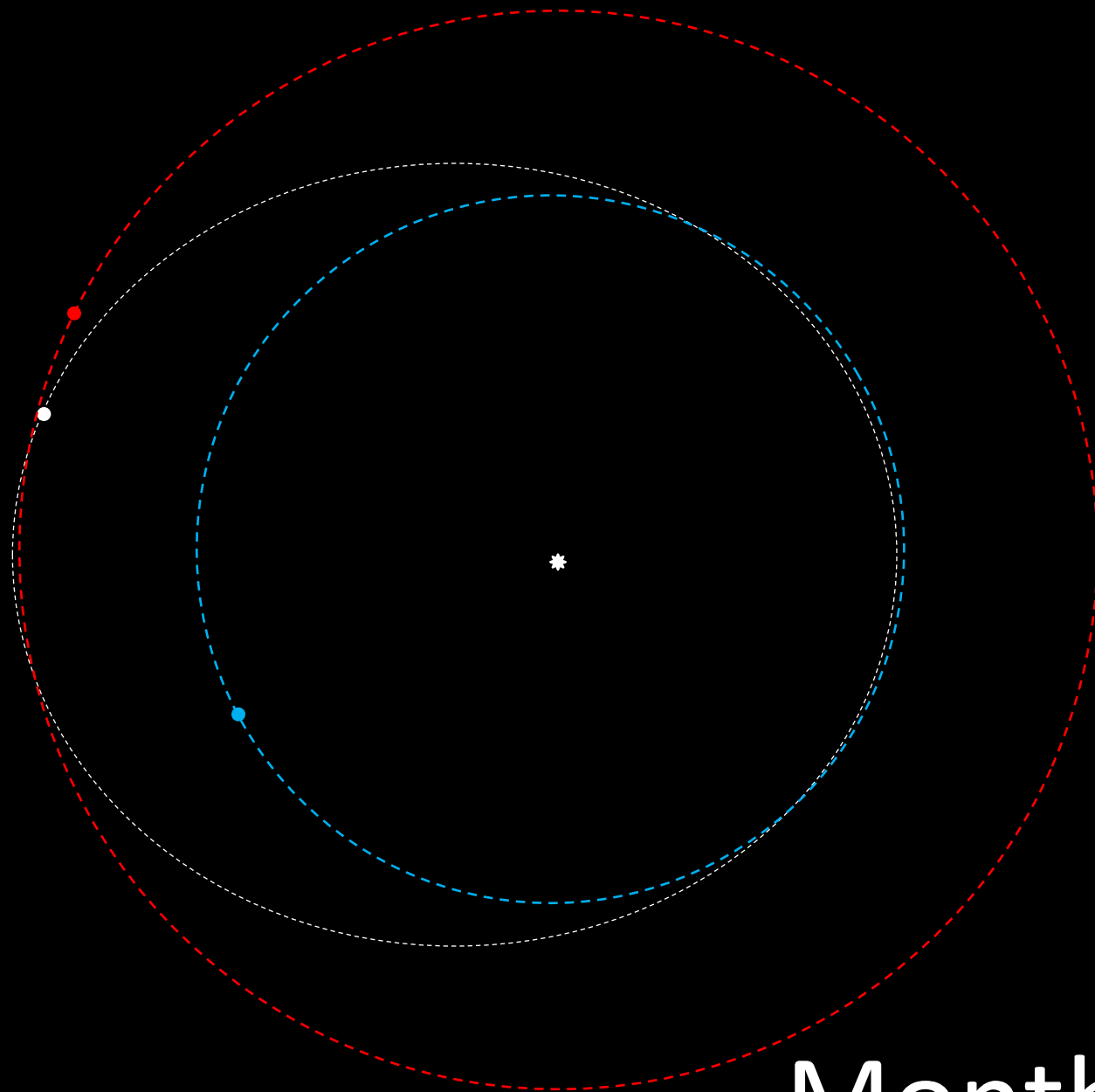
Month 4



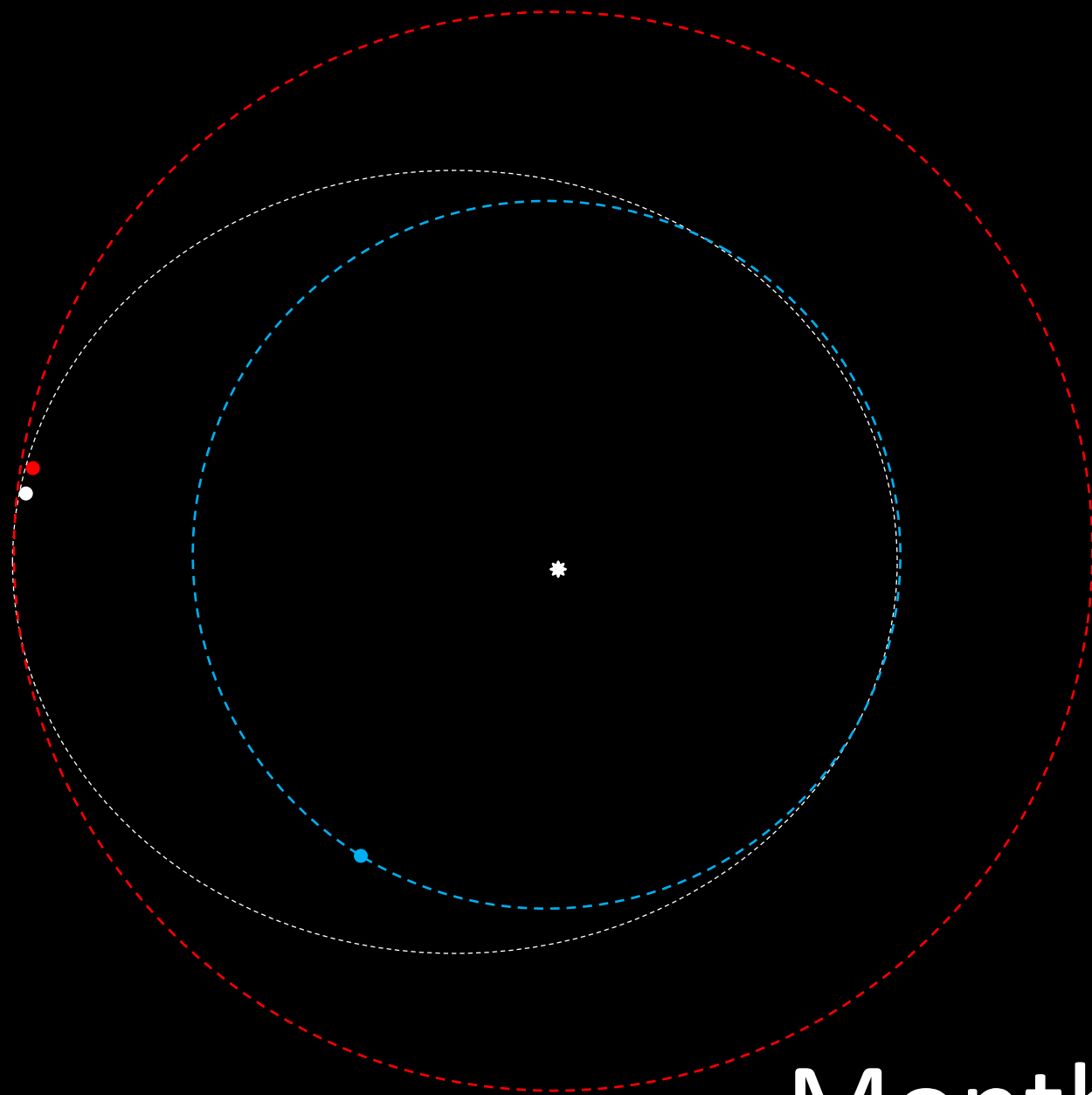
Month 5



Month 6



Month 7

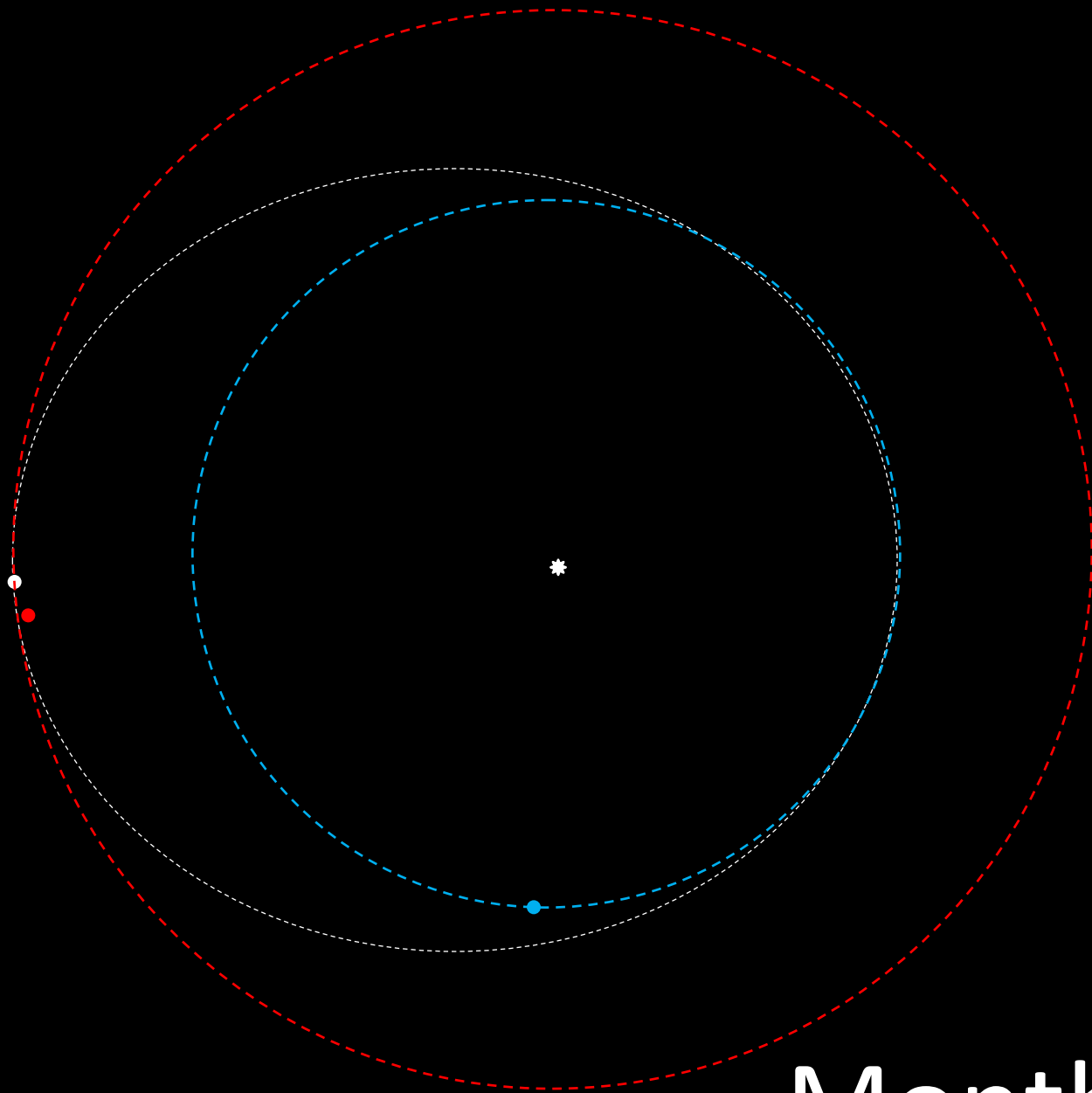


Month 8

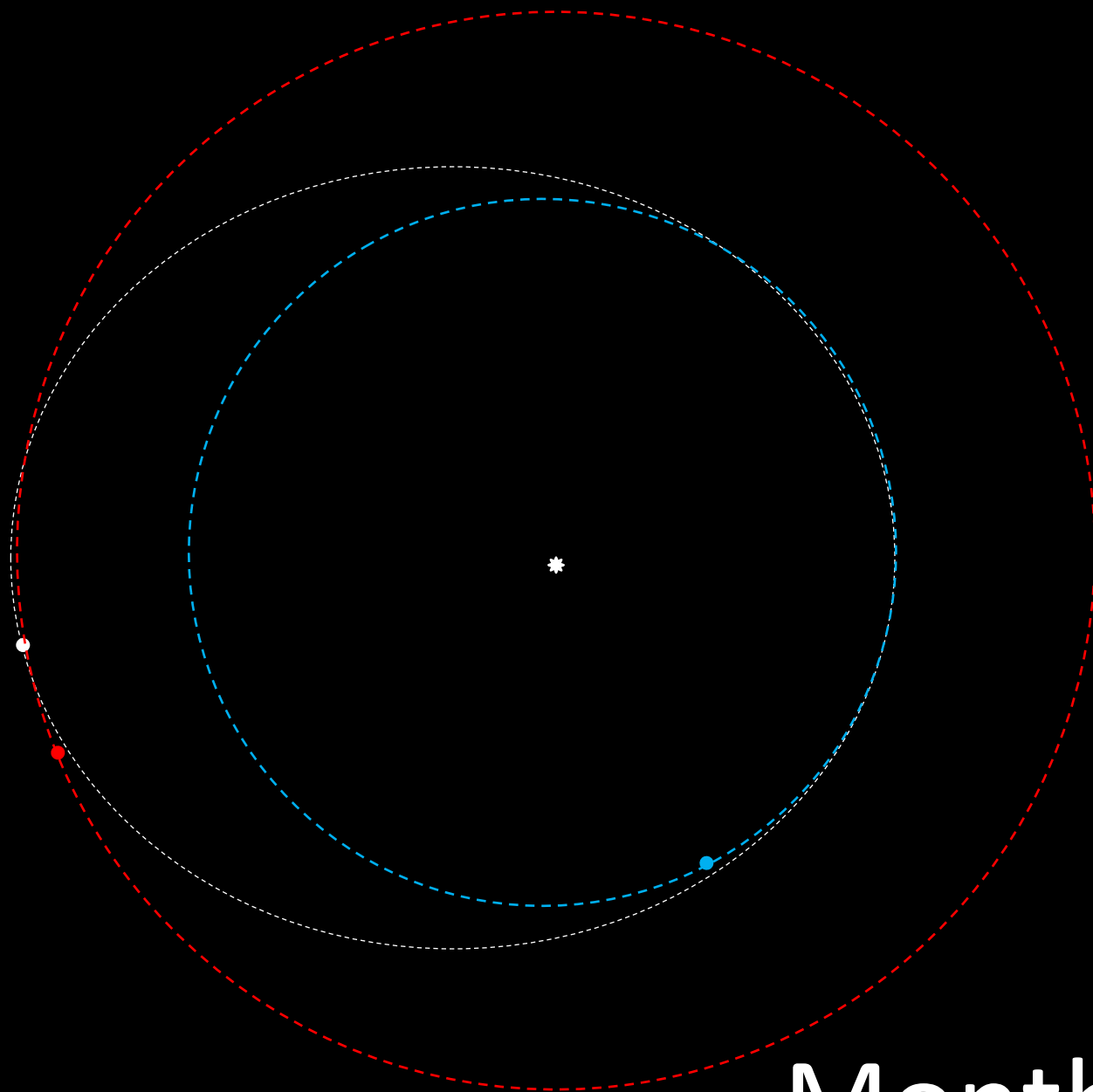


Now we're heroes!

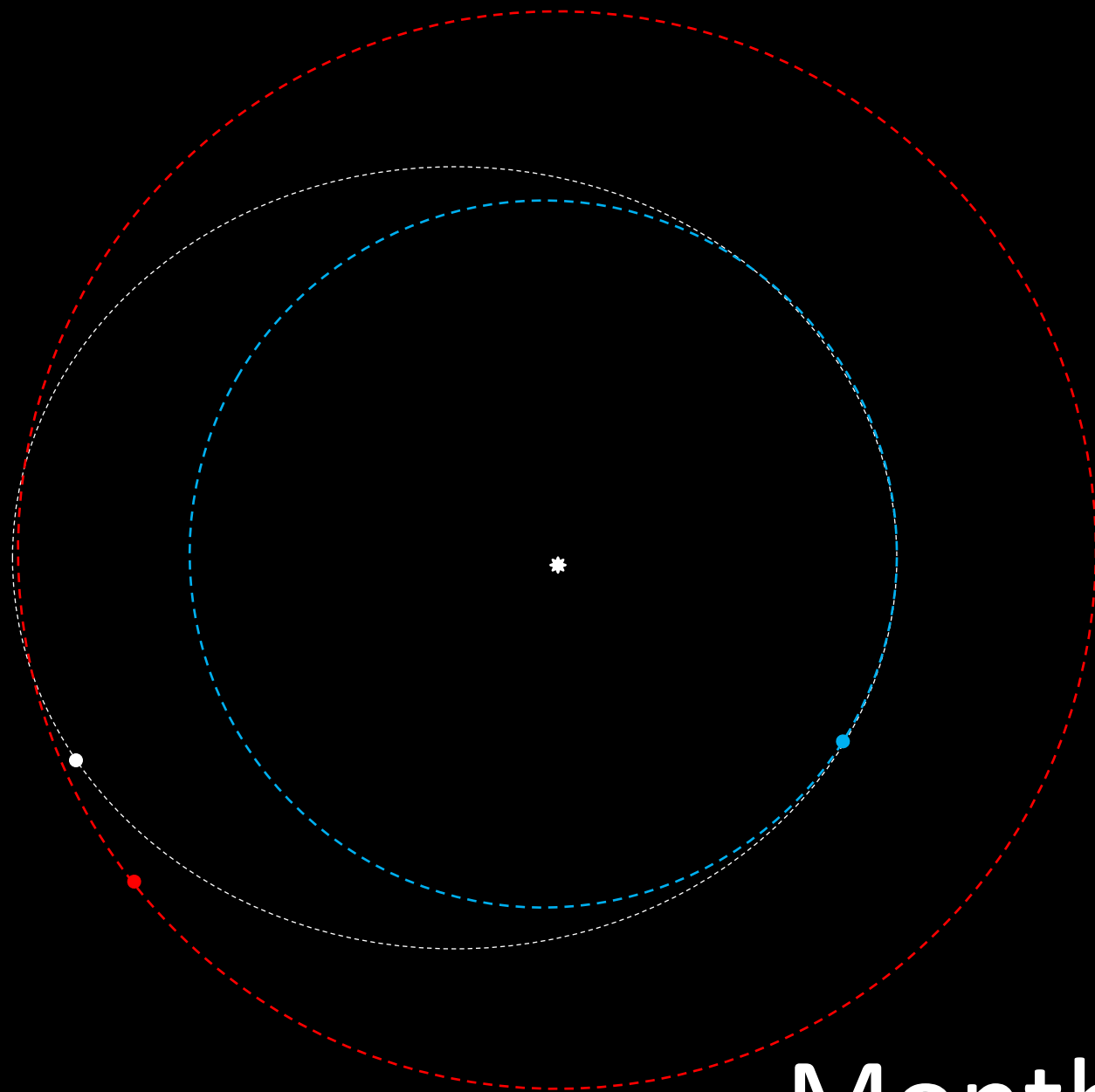
Month 8.5



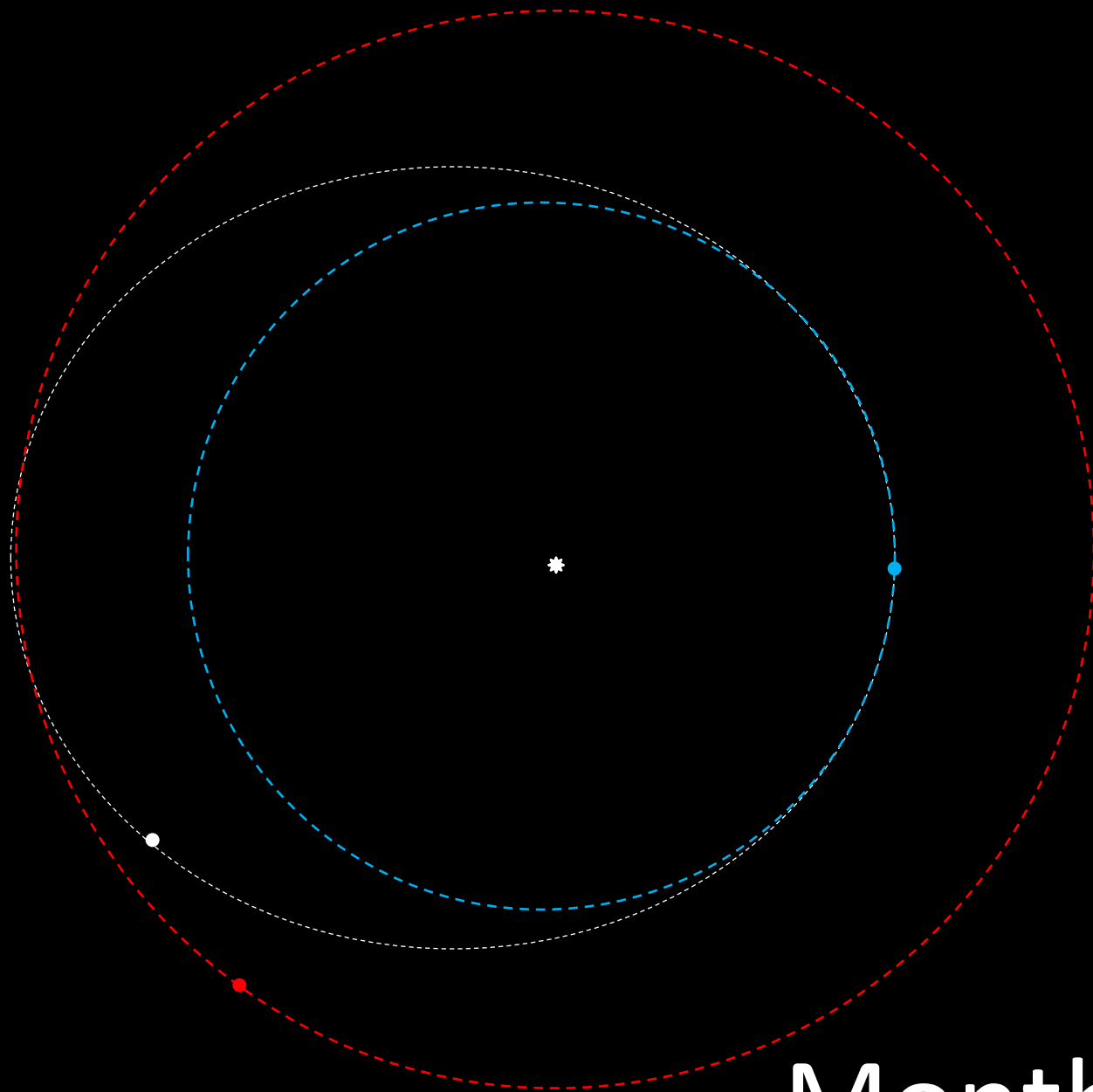
Month 9



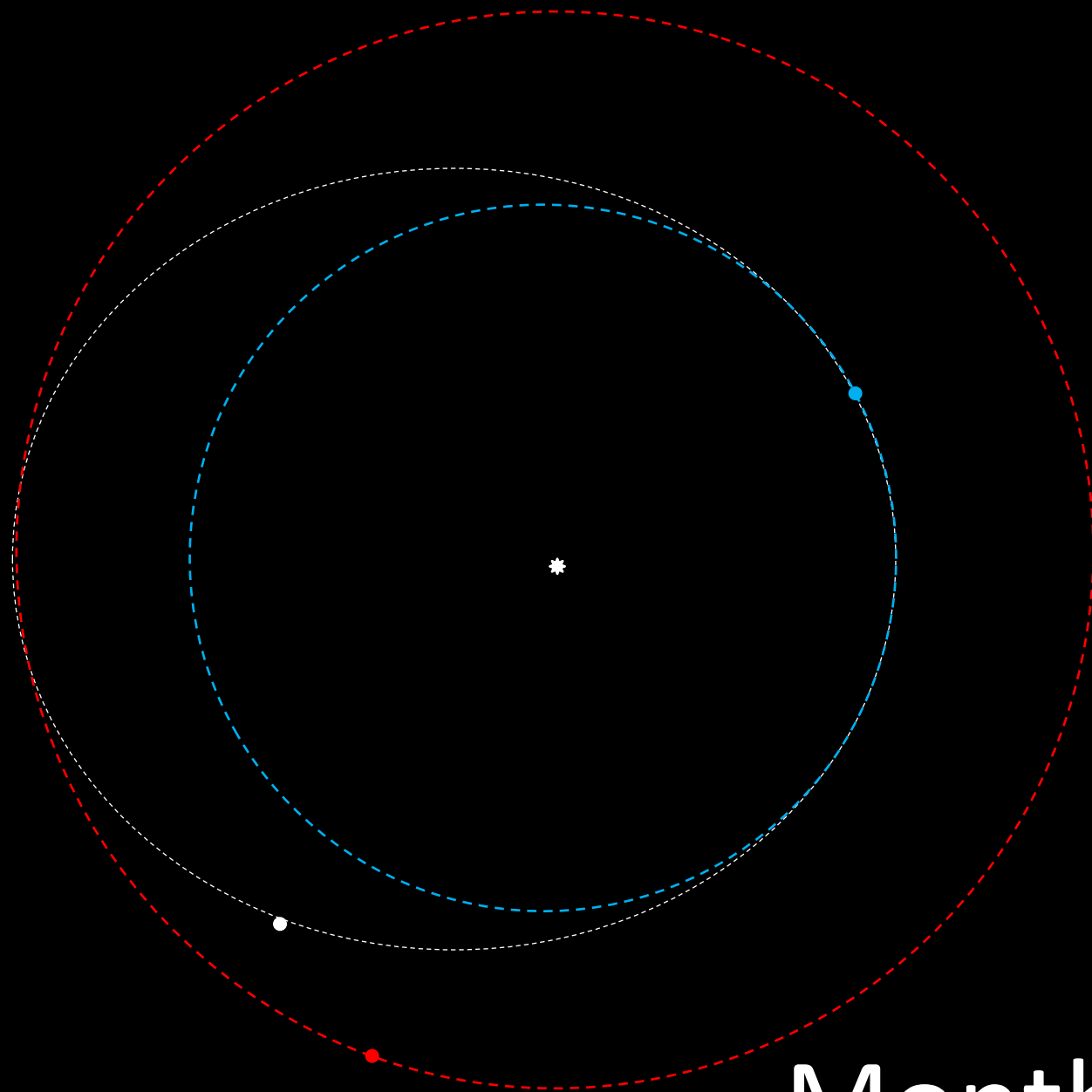
Month 10



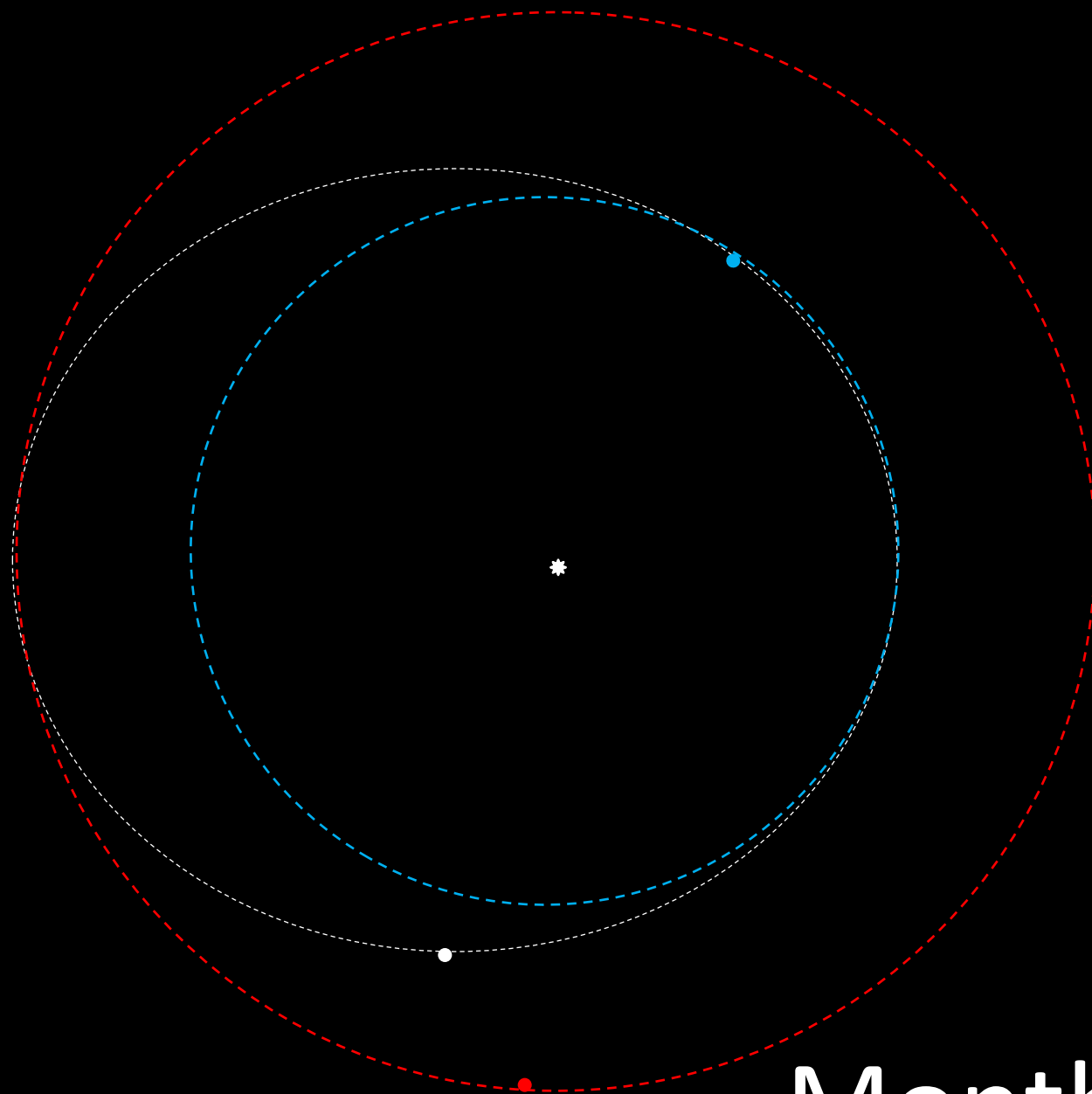
Month 11



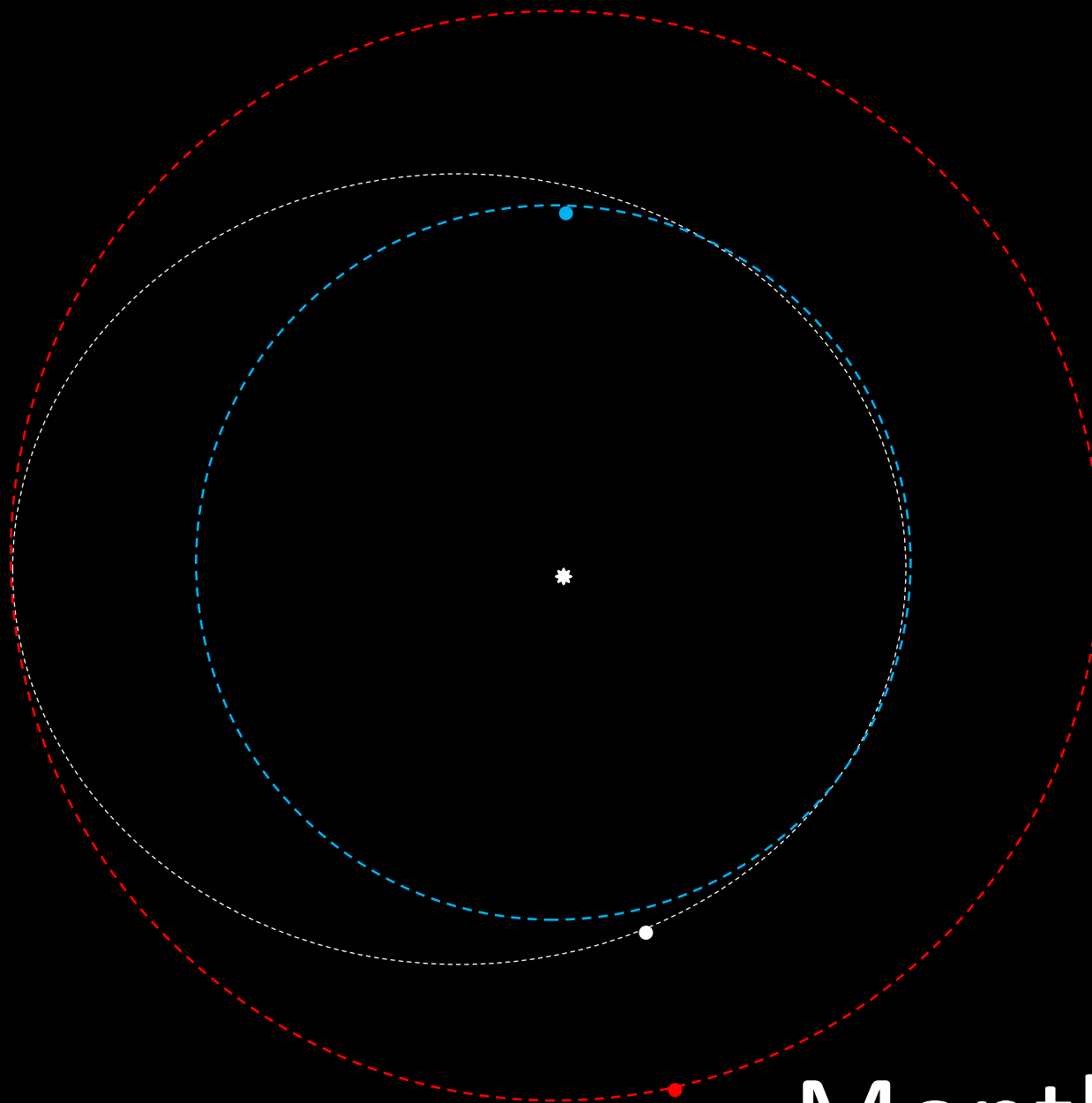
Month 12



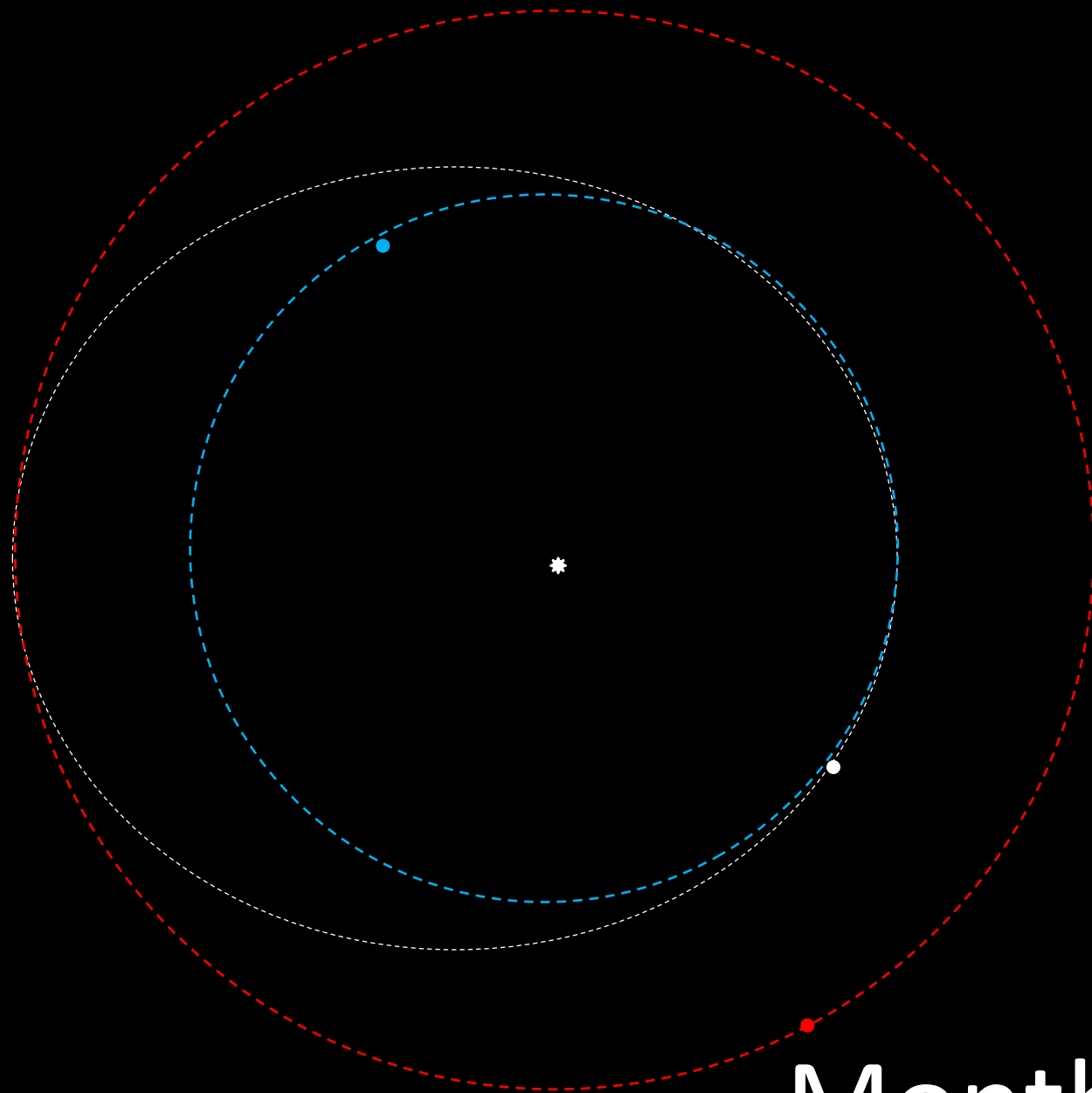
Month 13



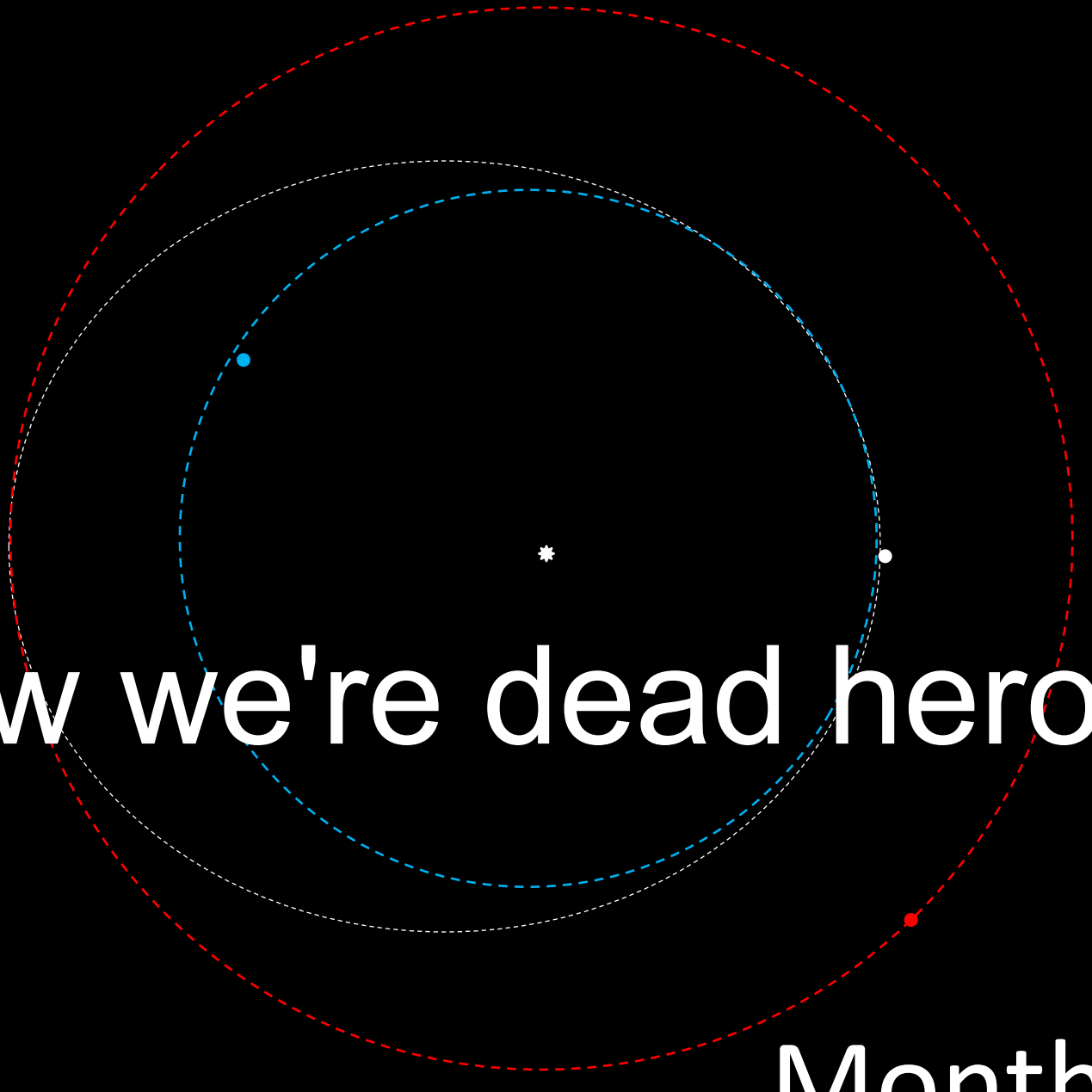
Month 14



Month 15

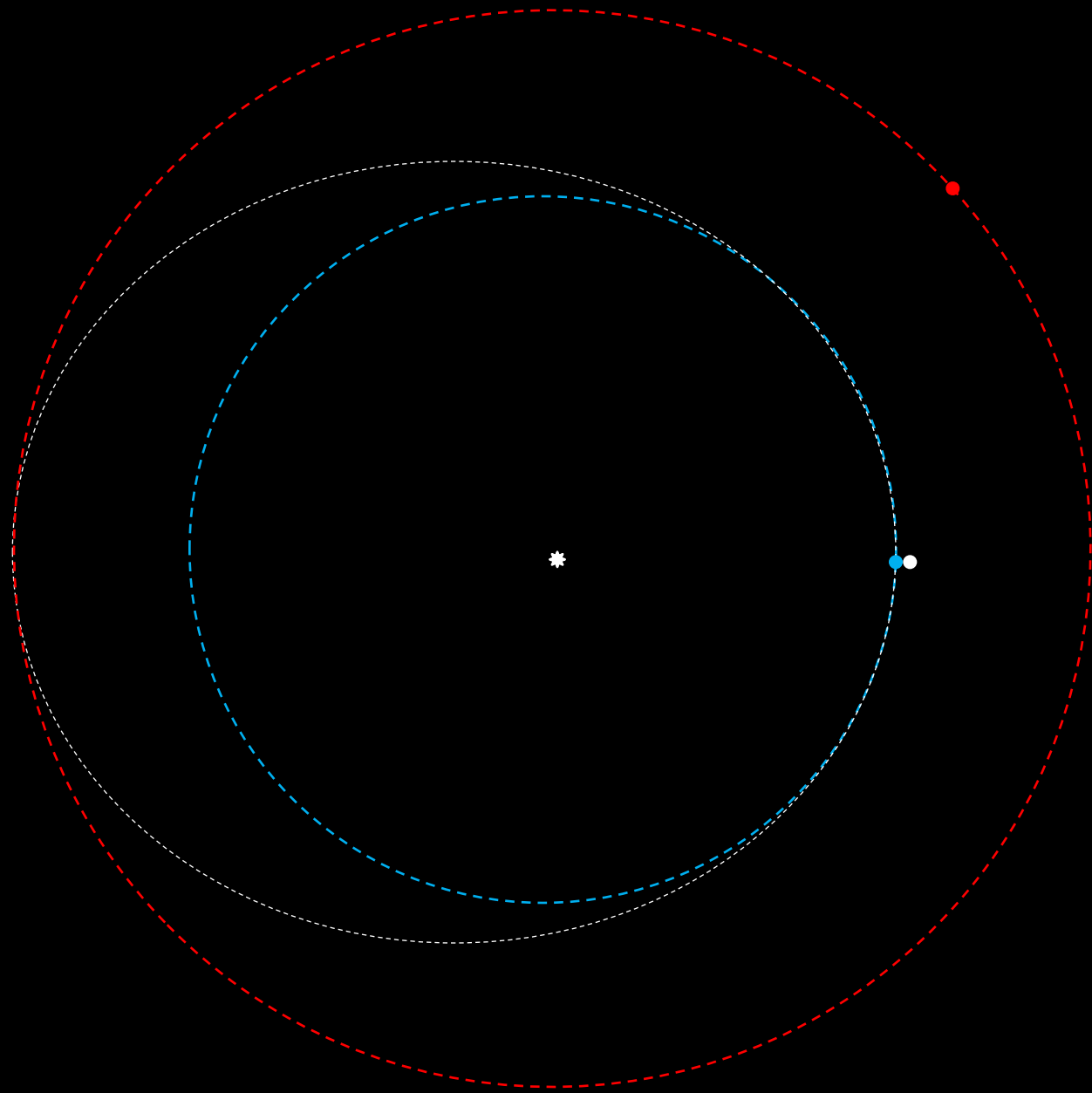


Month 16



Now we're dead heroes.

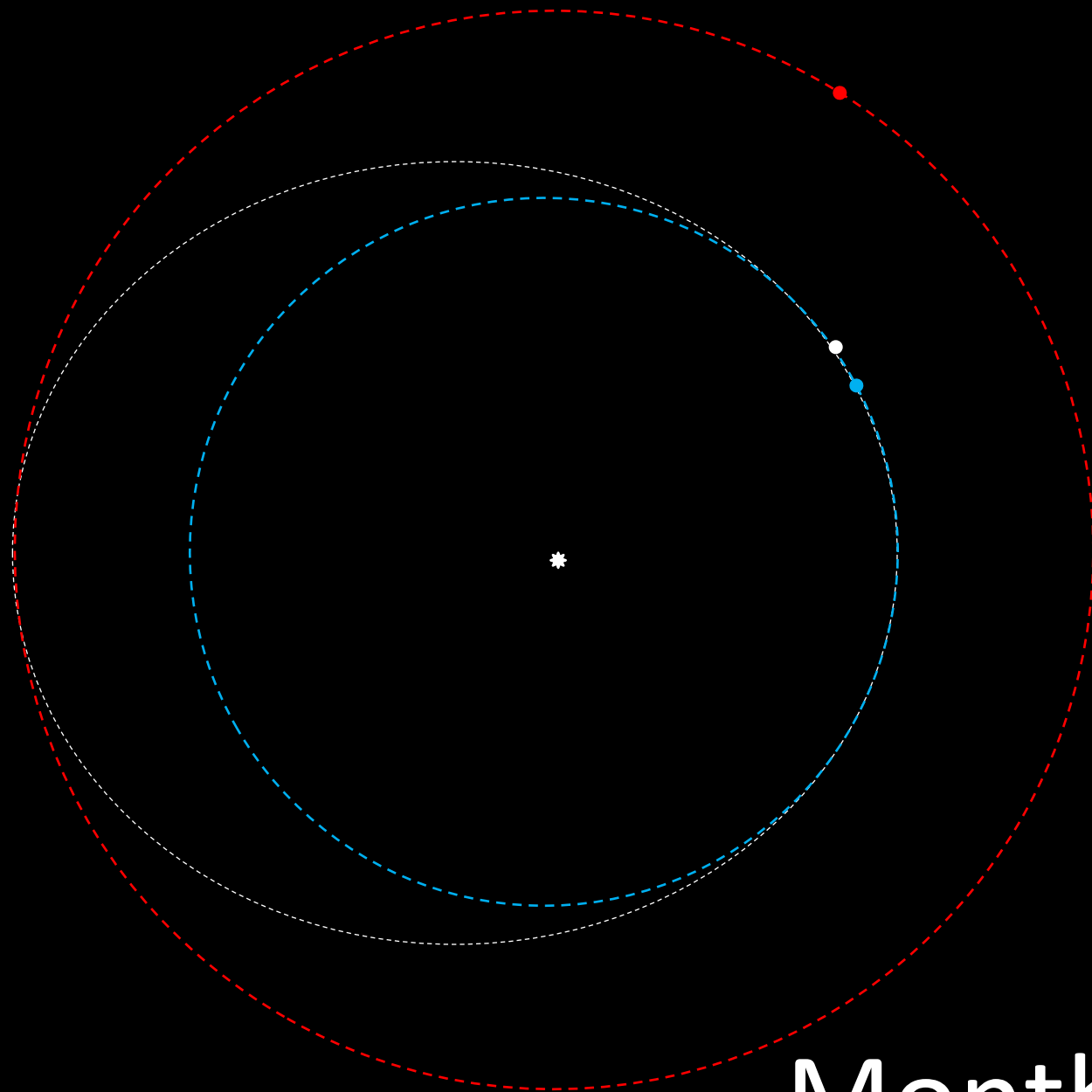
Month 17



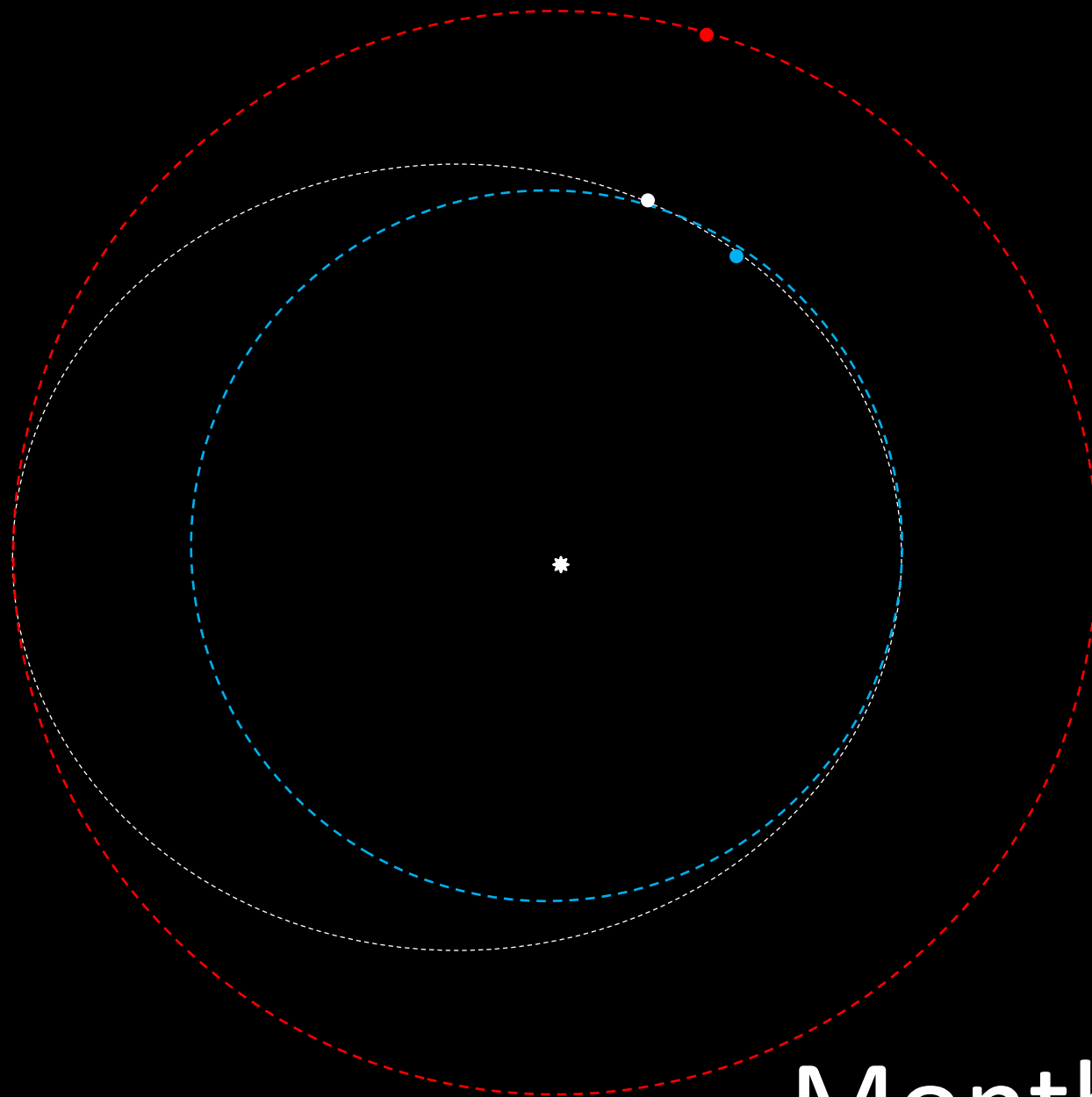


Go!

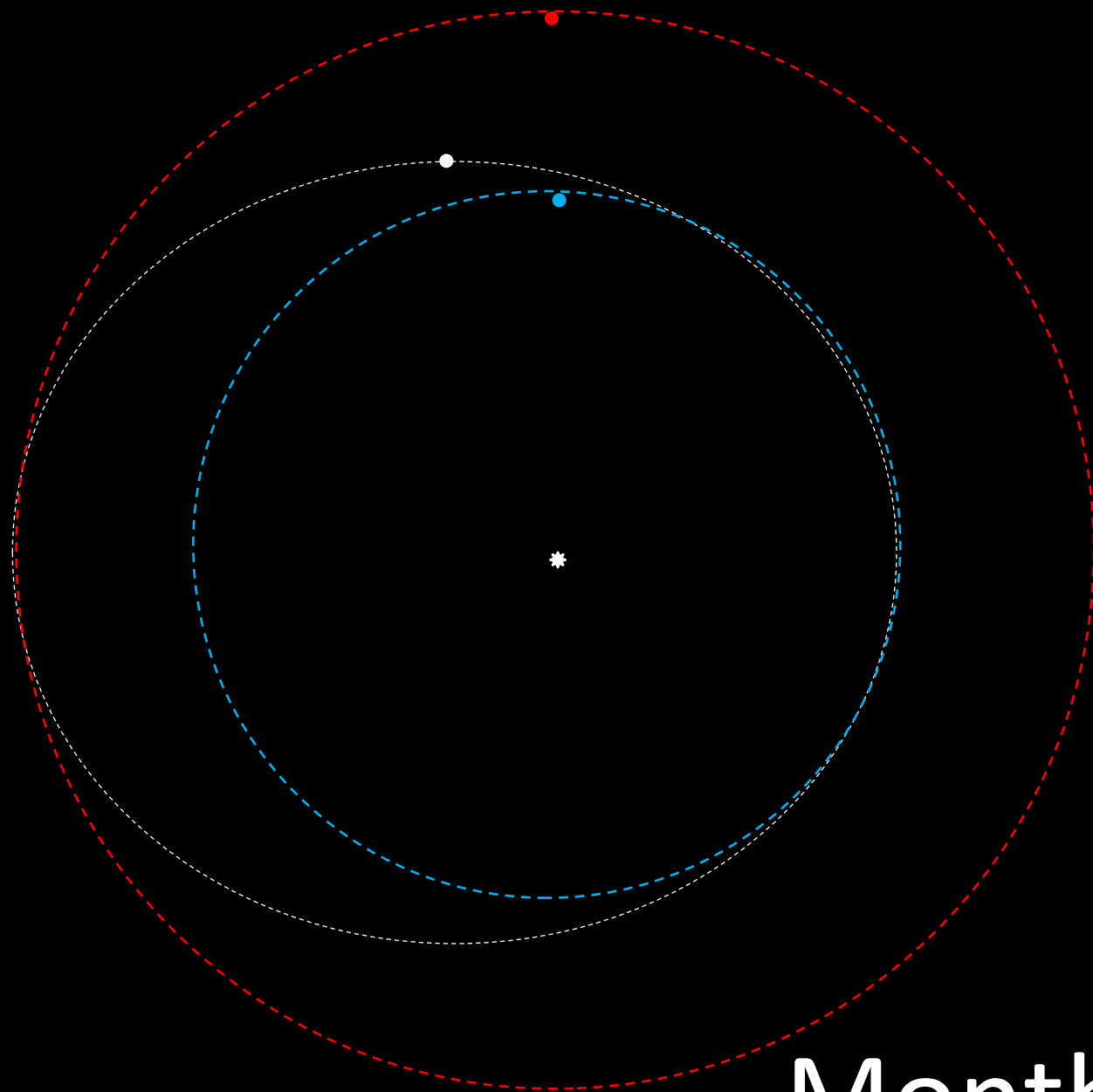
Month 0



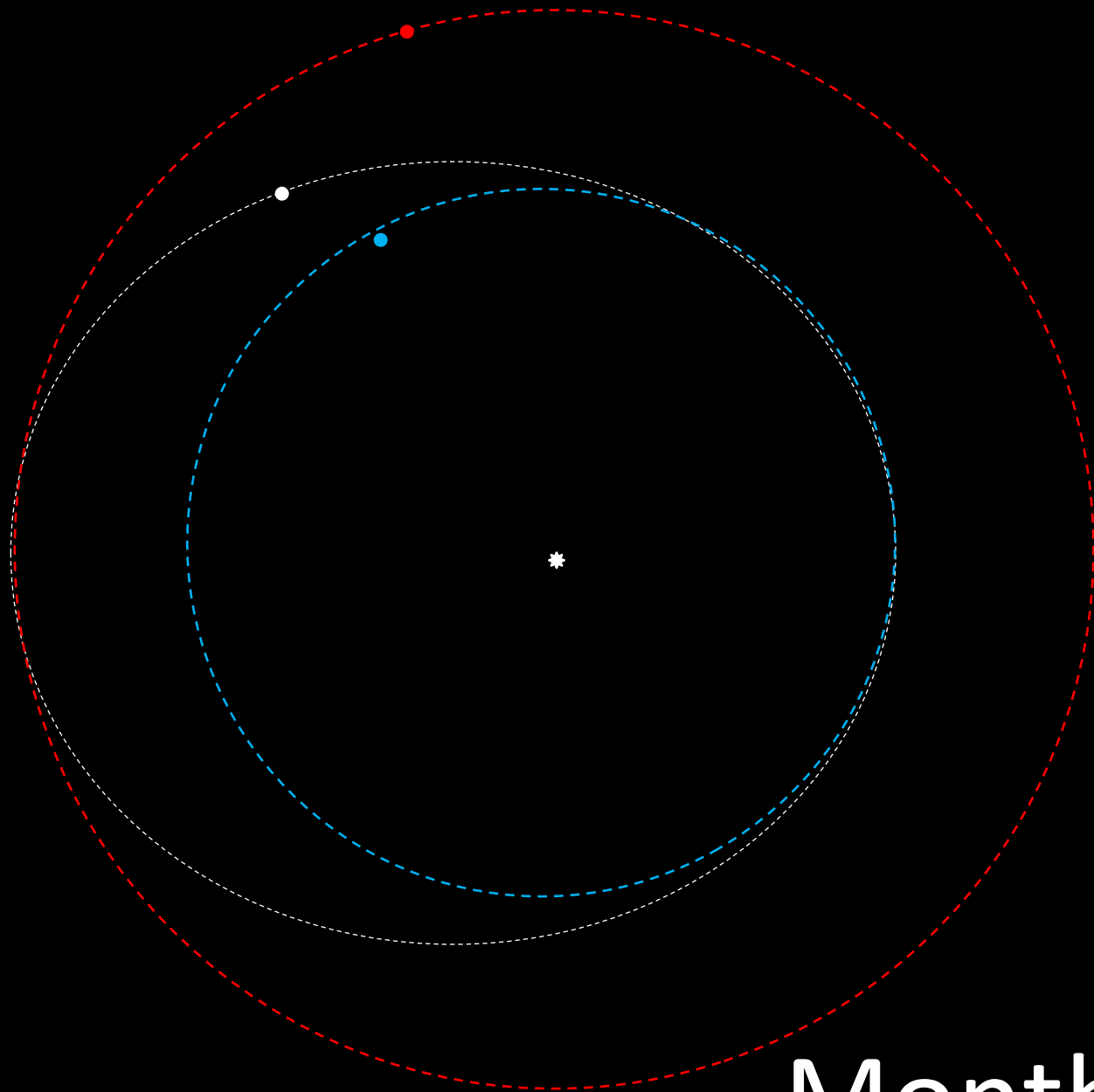
Month 1



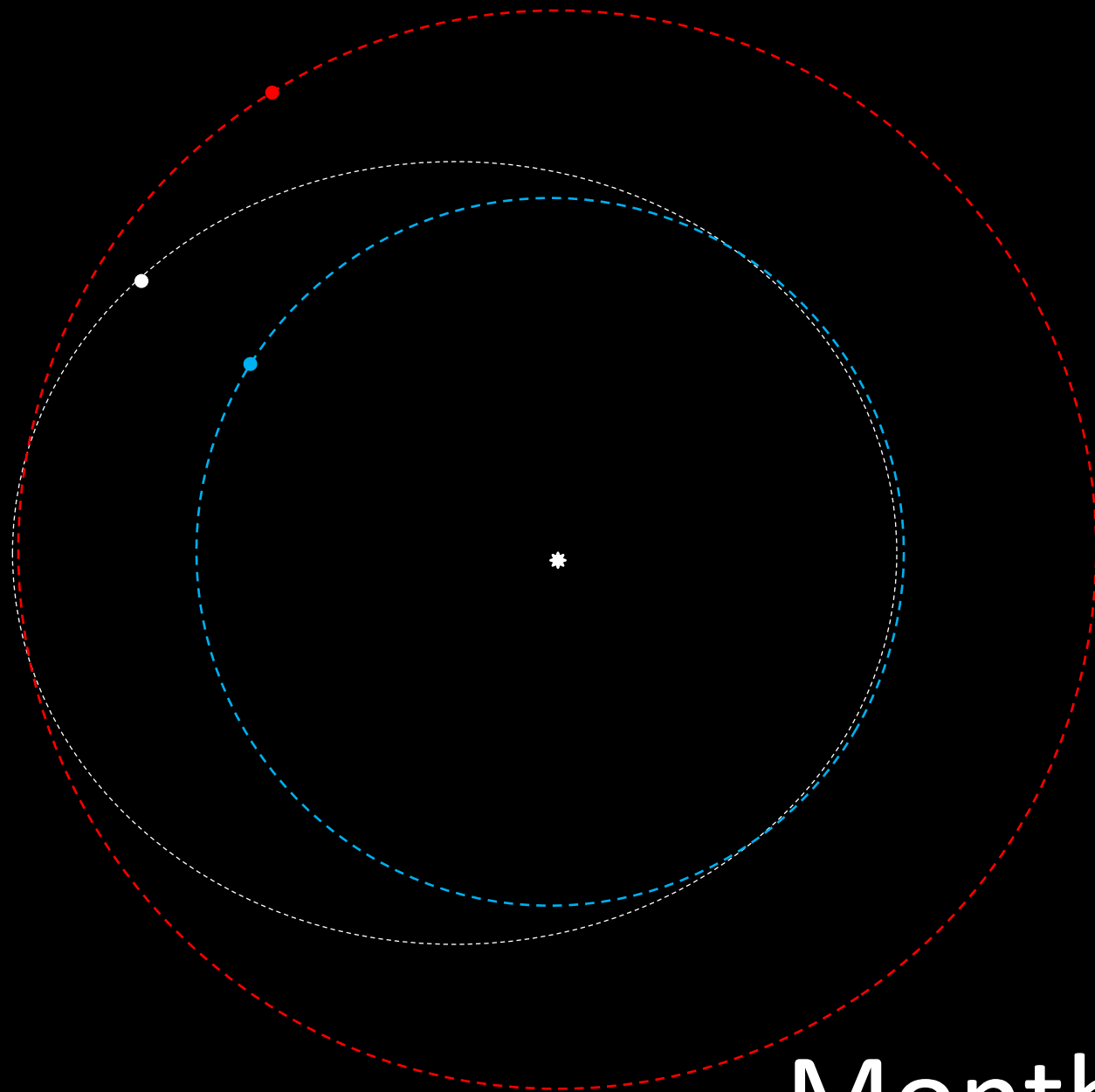
Month 2



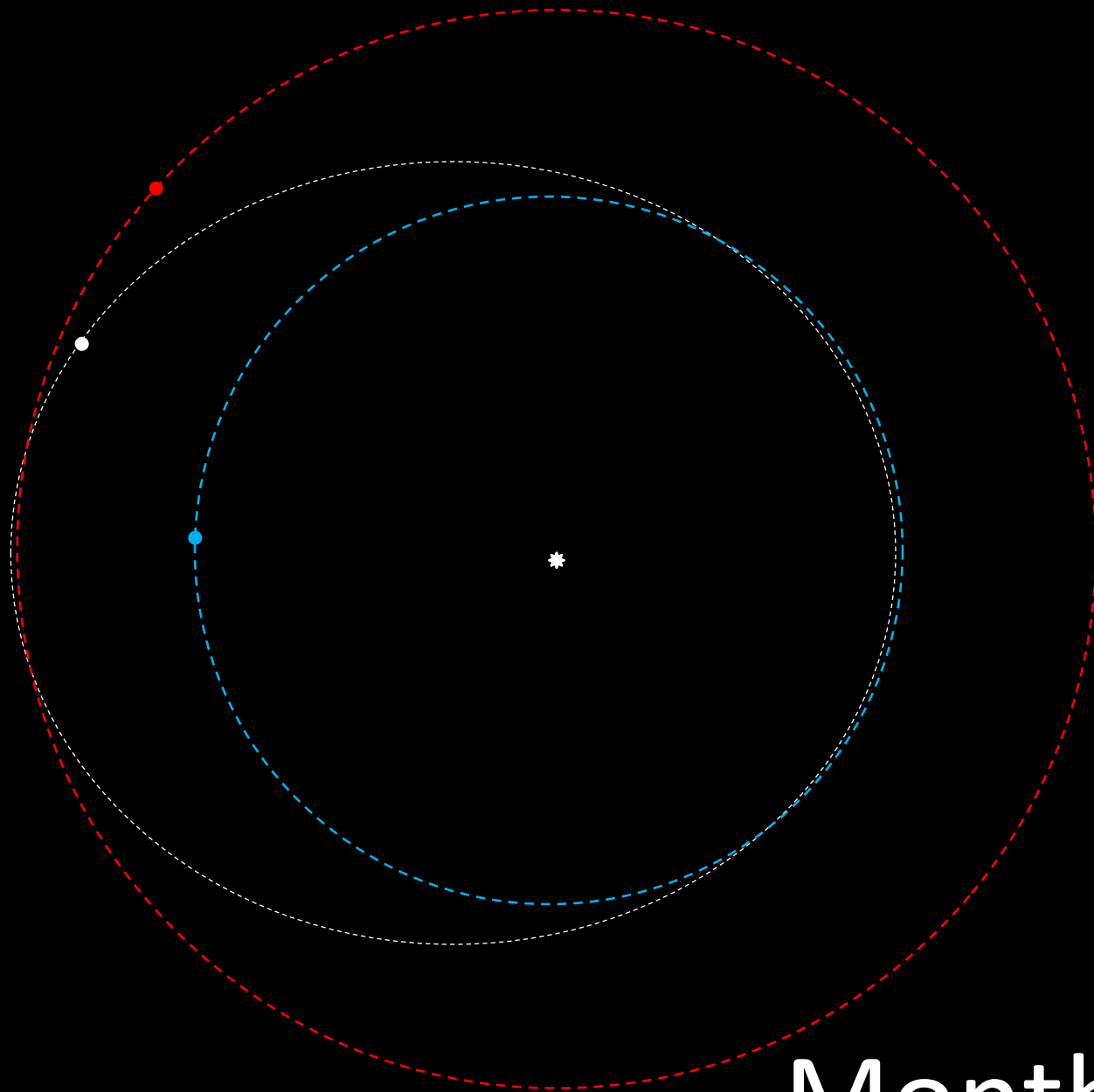
Month 3



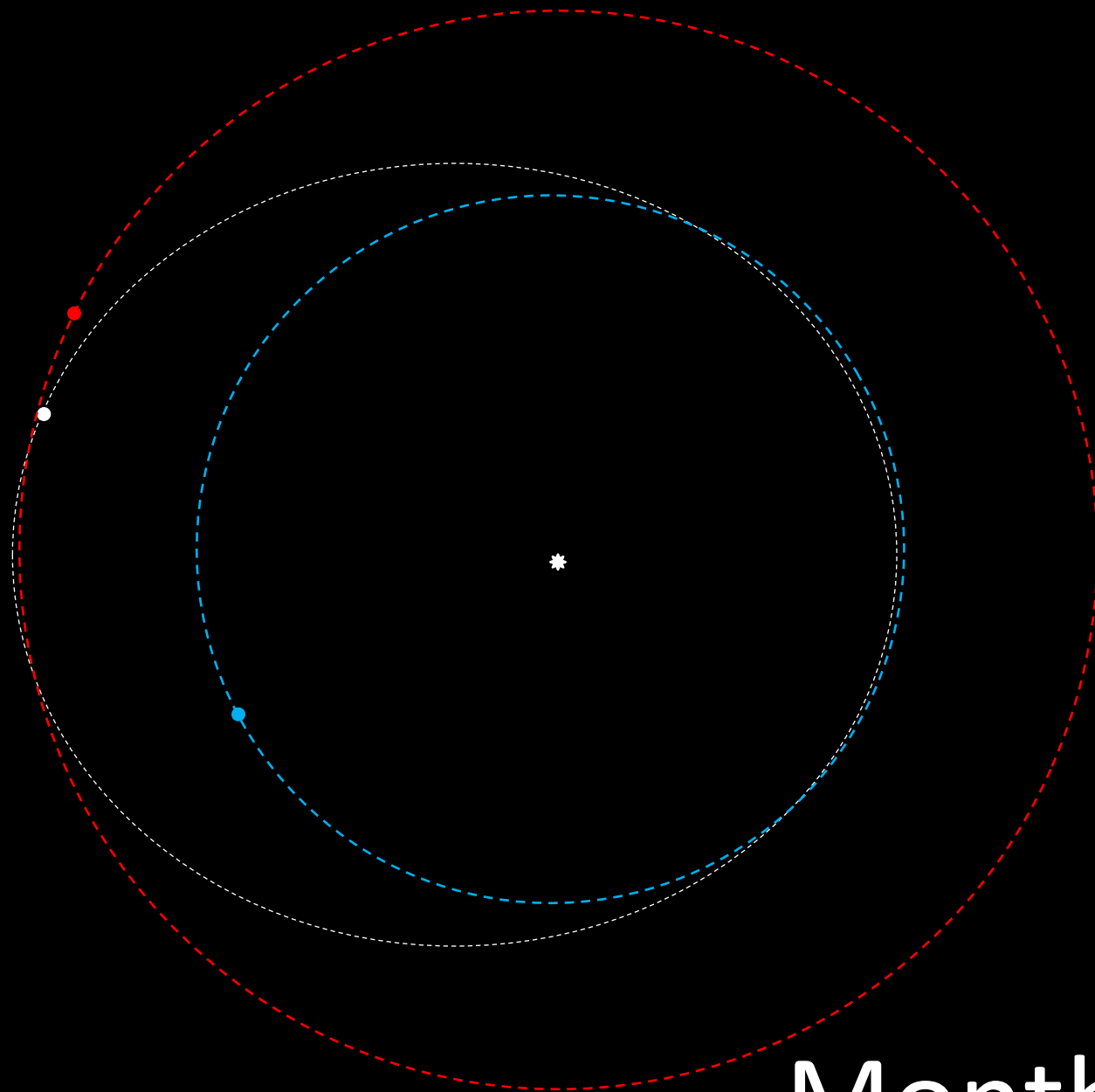
Month 4



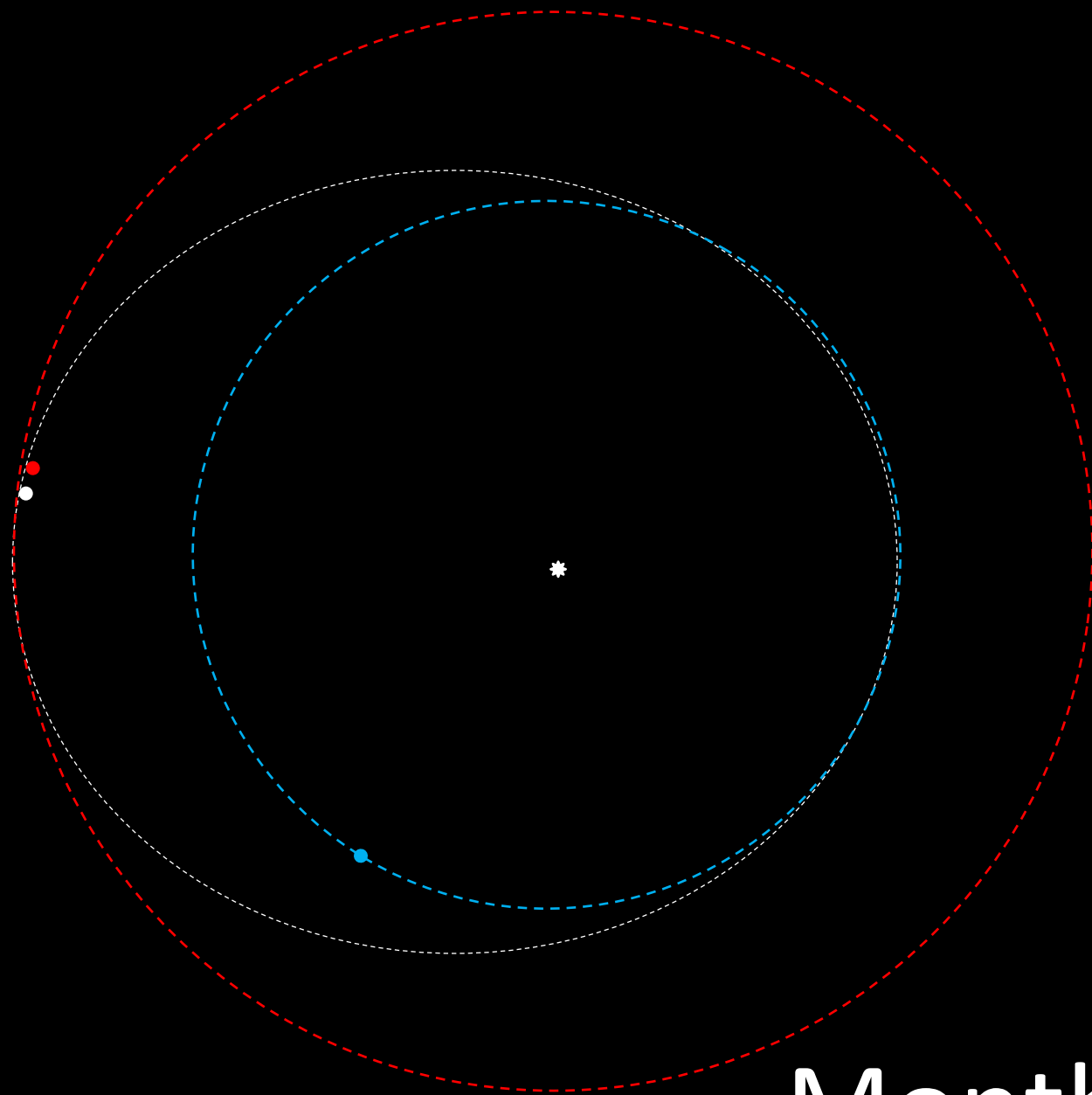
Month 5



Month 6



Month 7

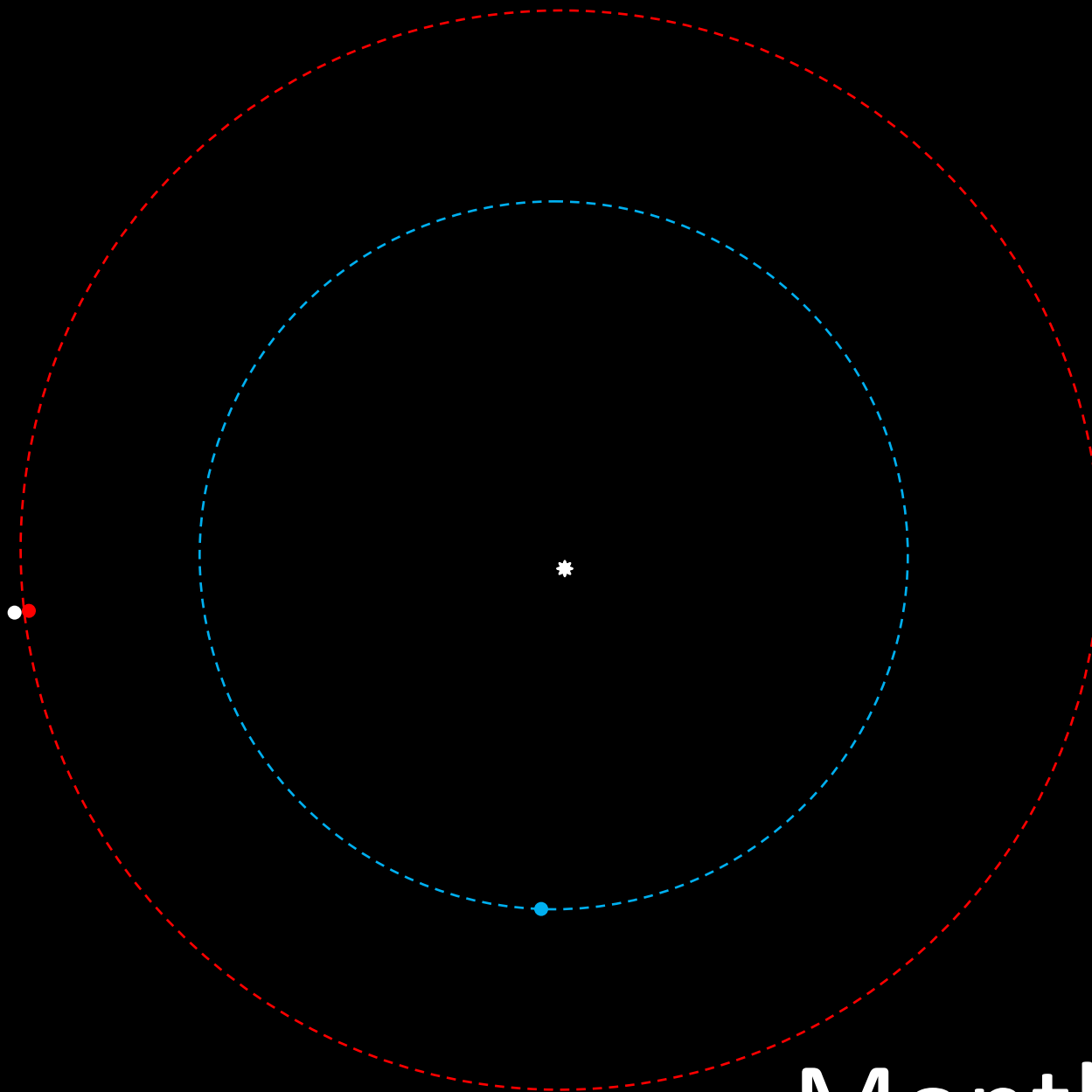


Month 8

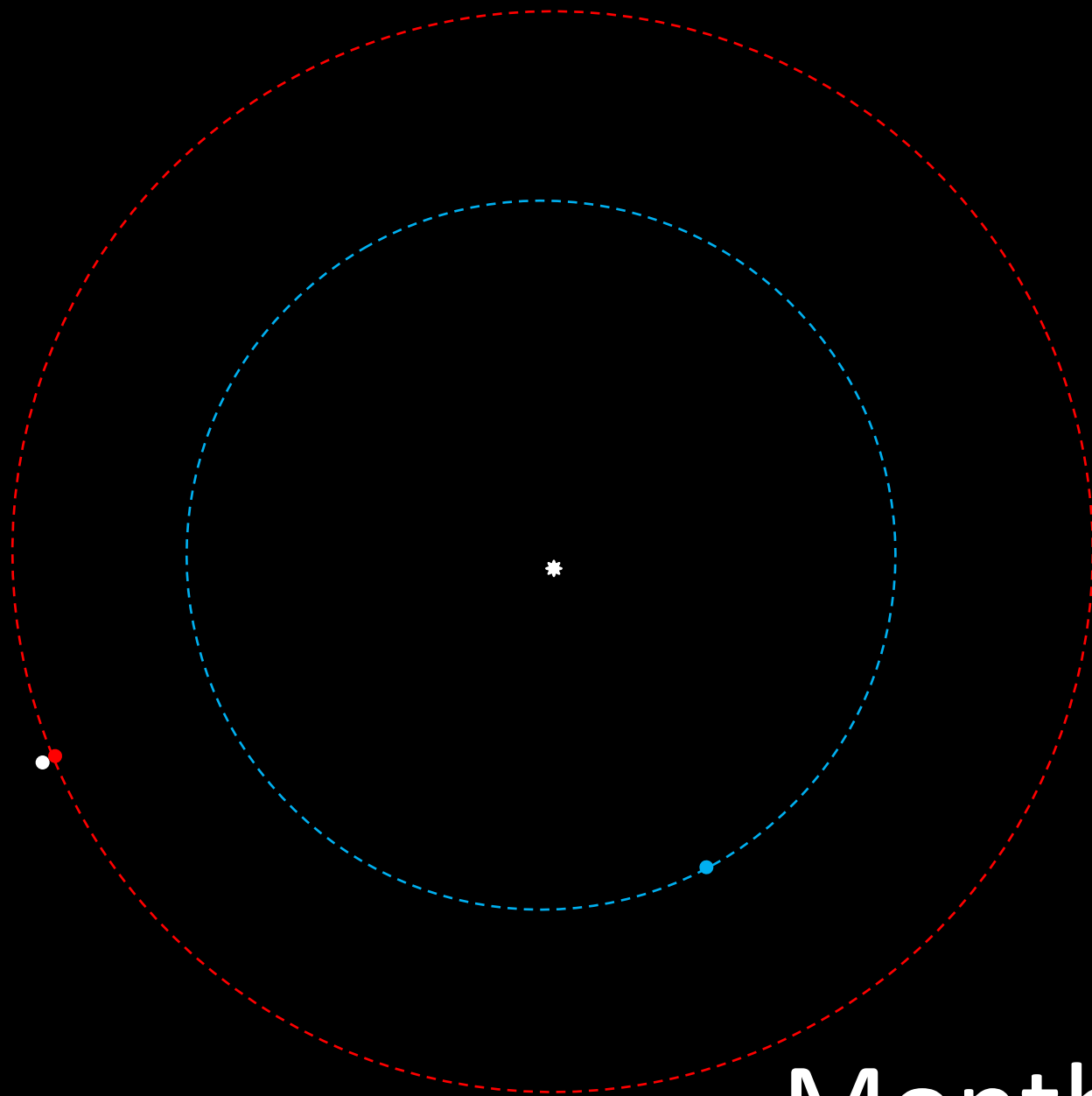


We made it!

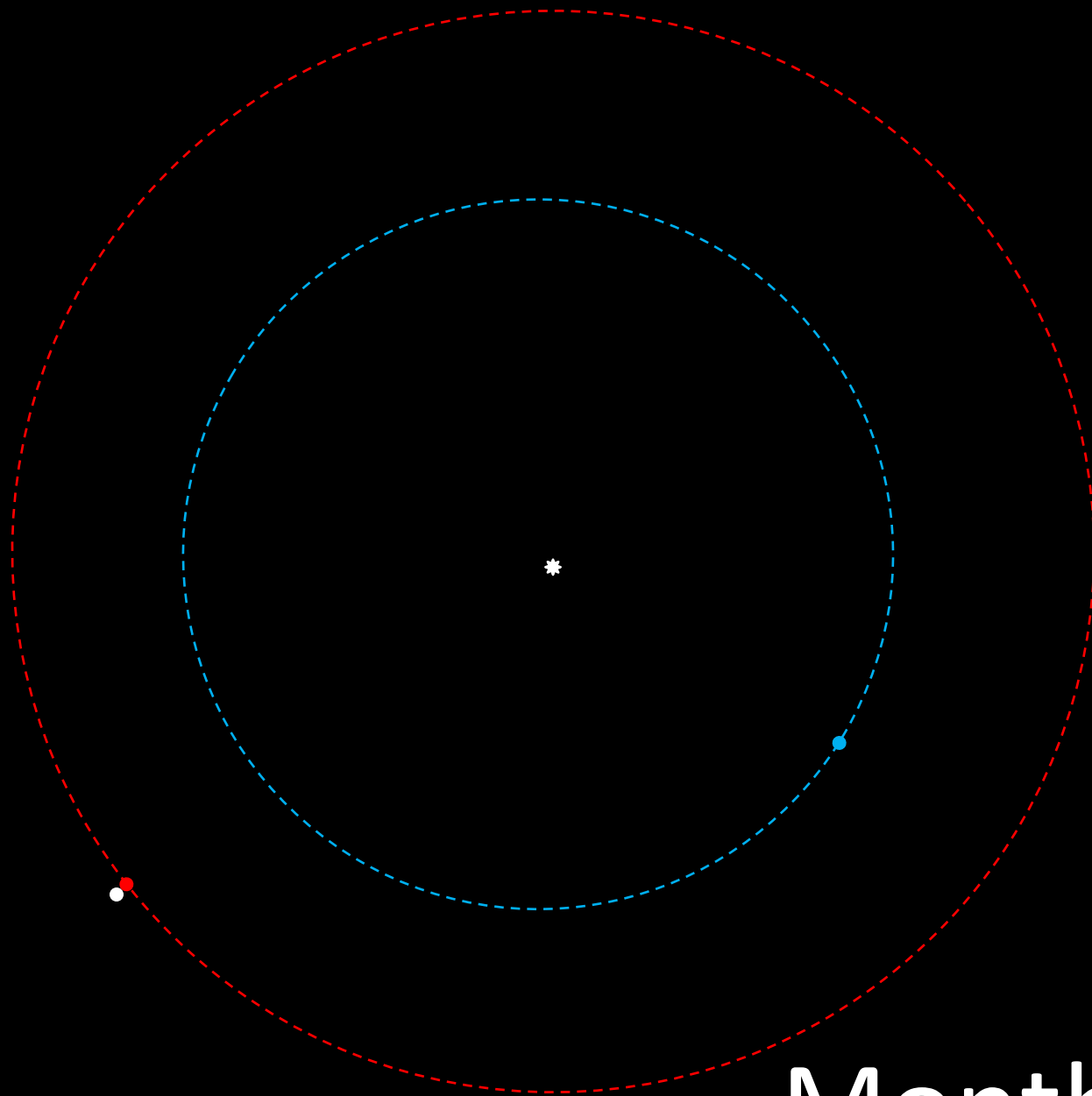
Month 8.5



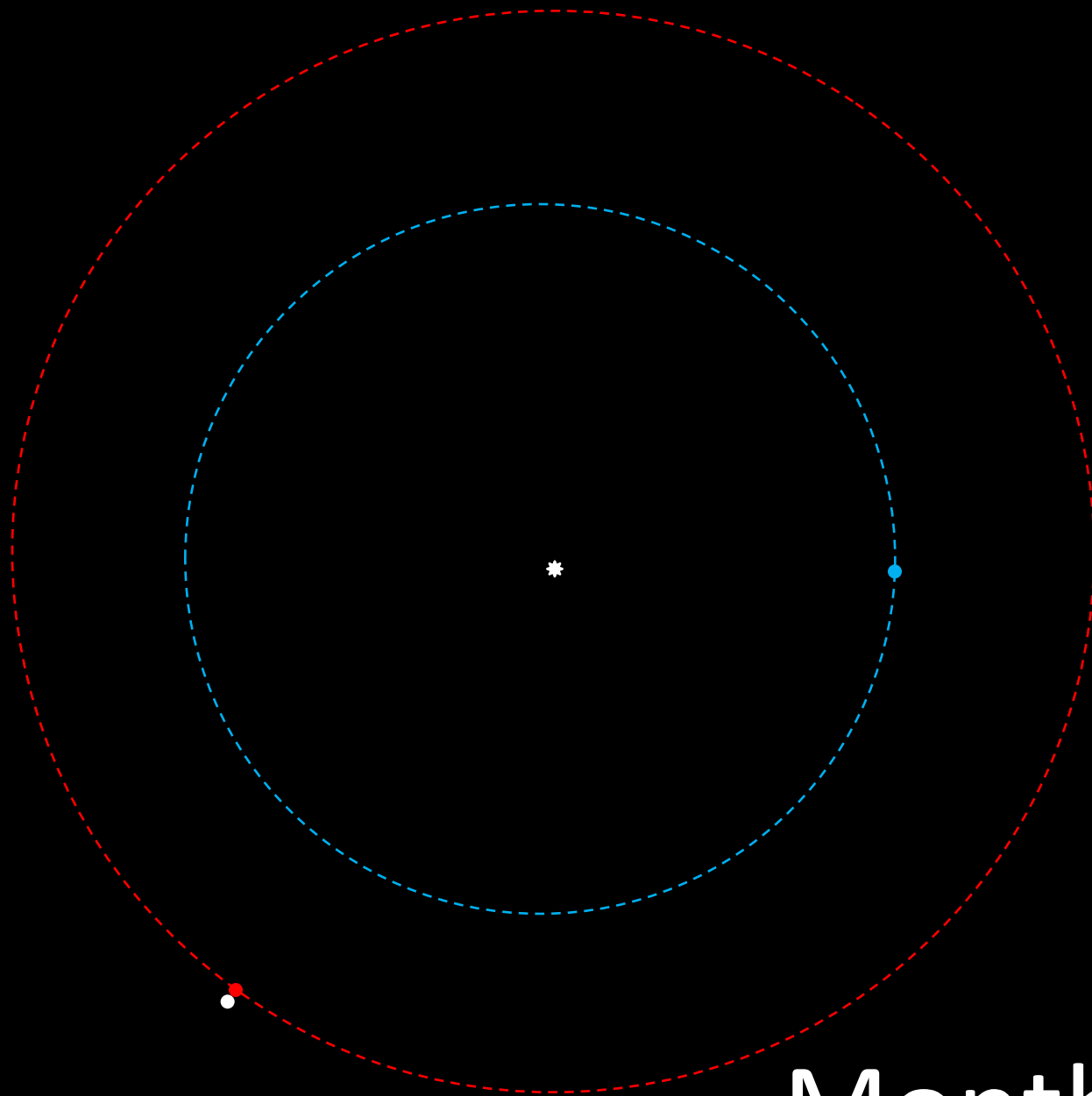
Month 9



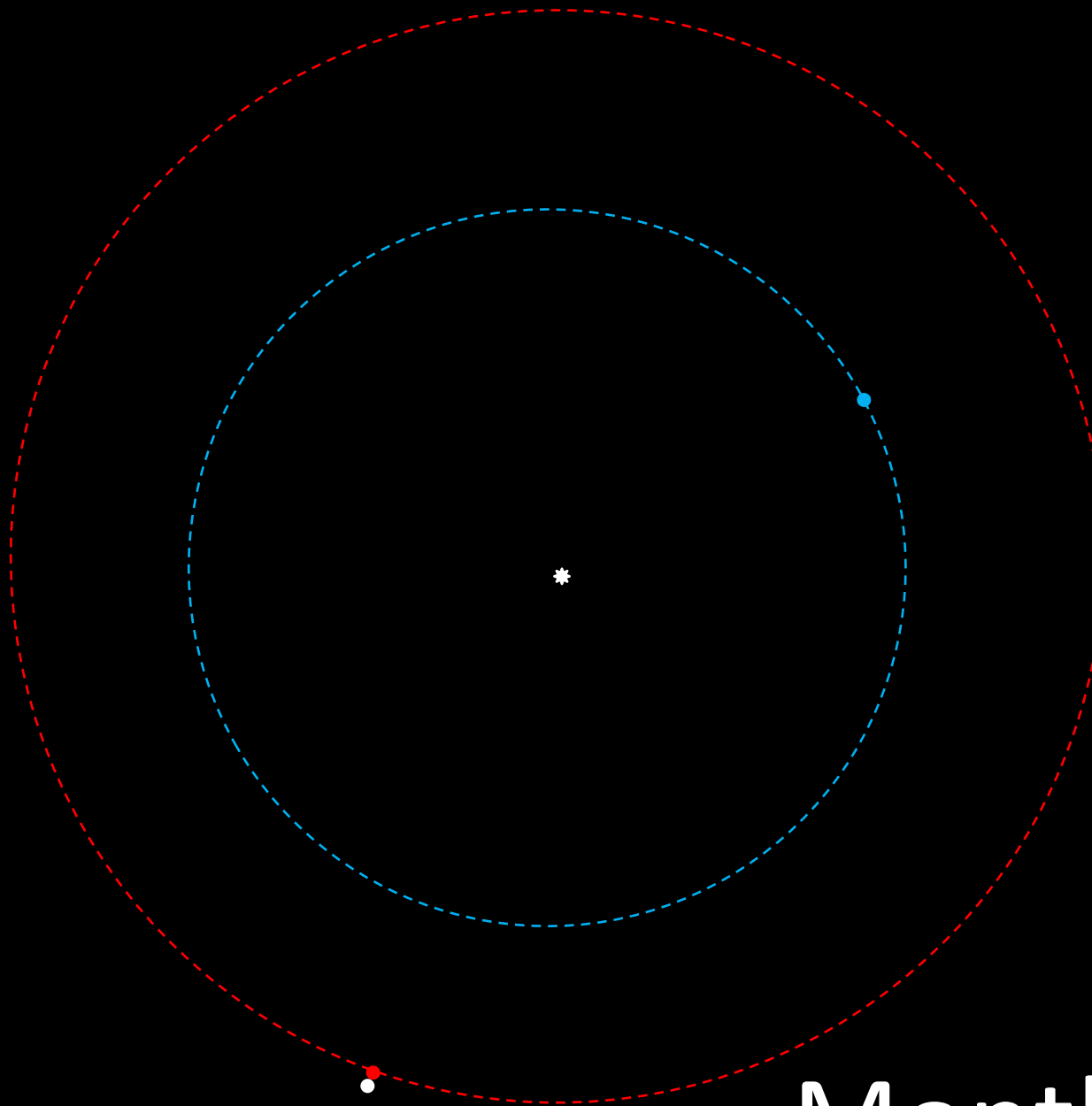
Month 10



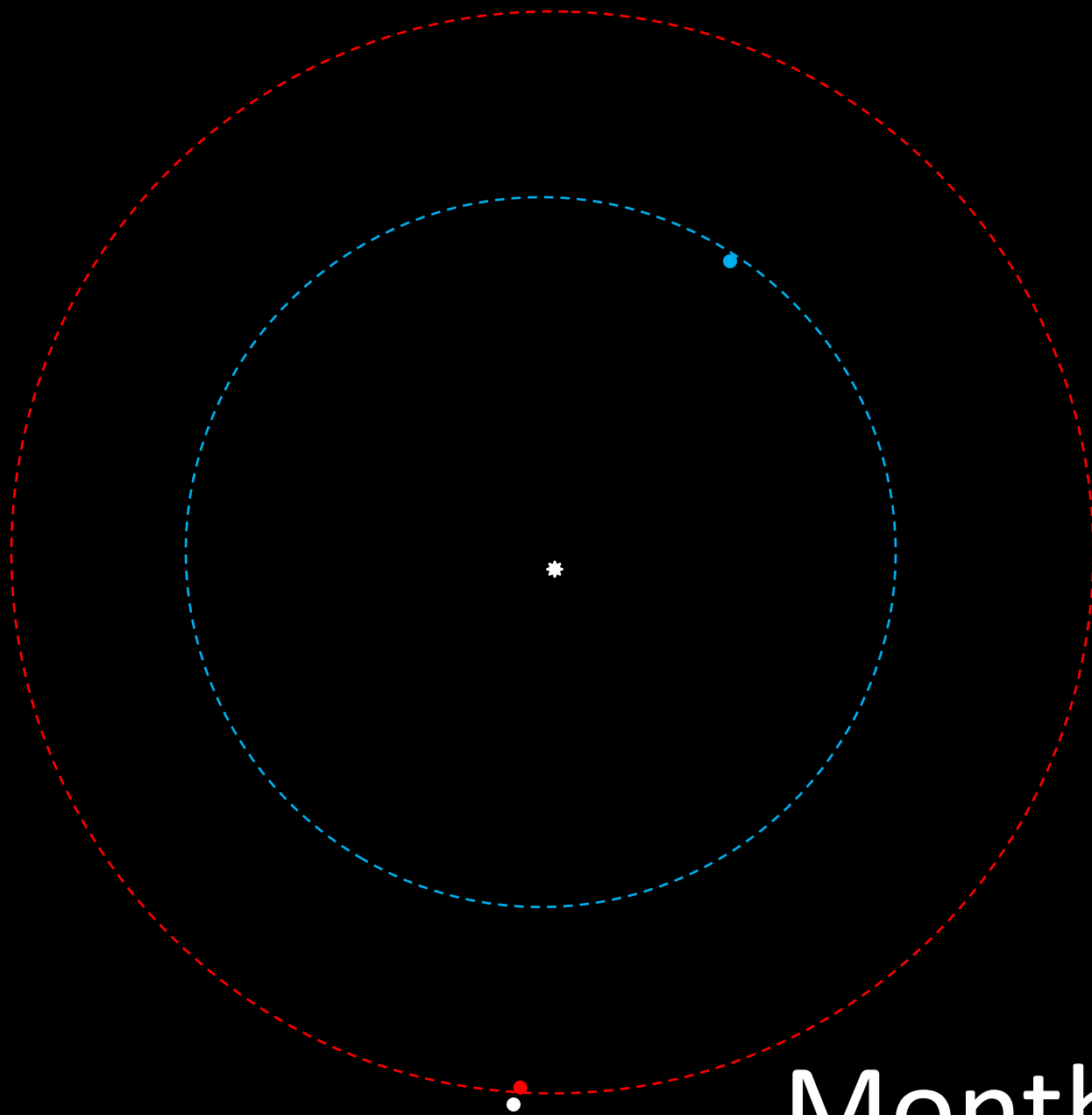
Month 11



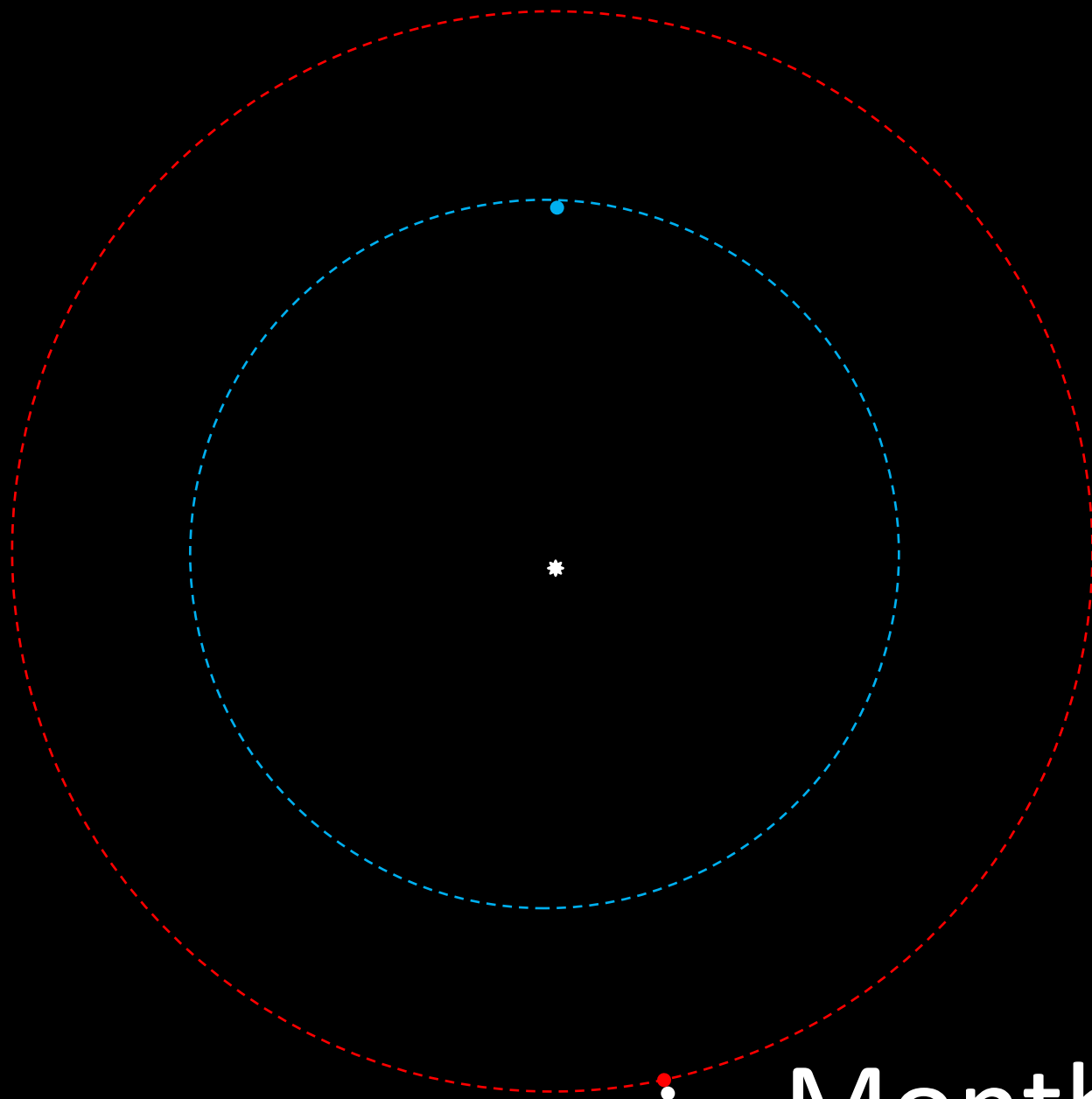
Month 12



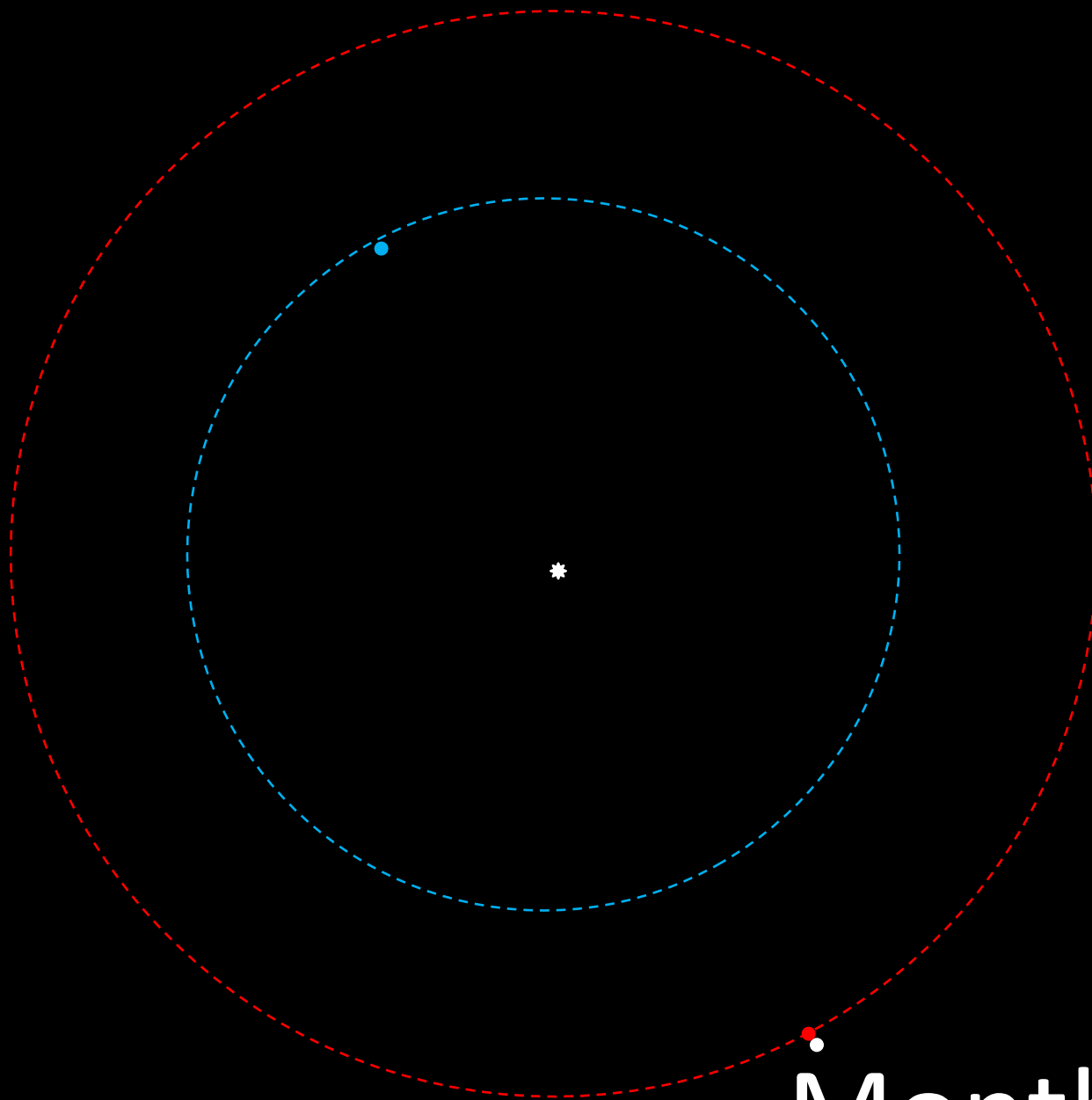
Month 13



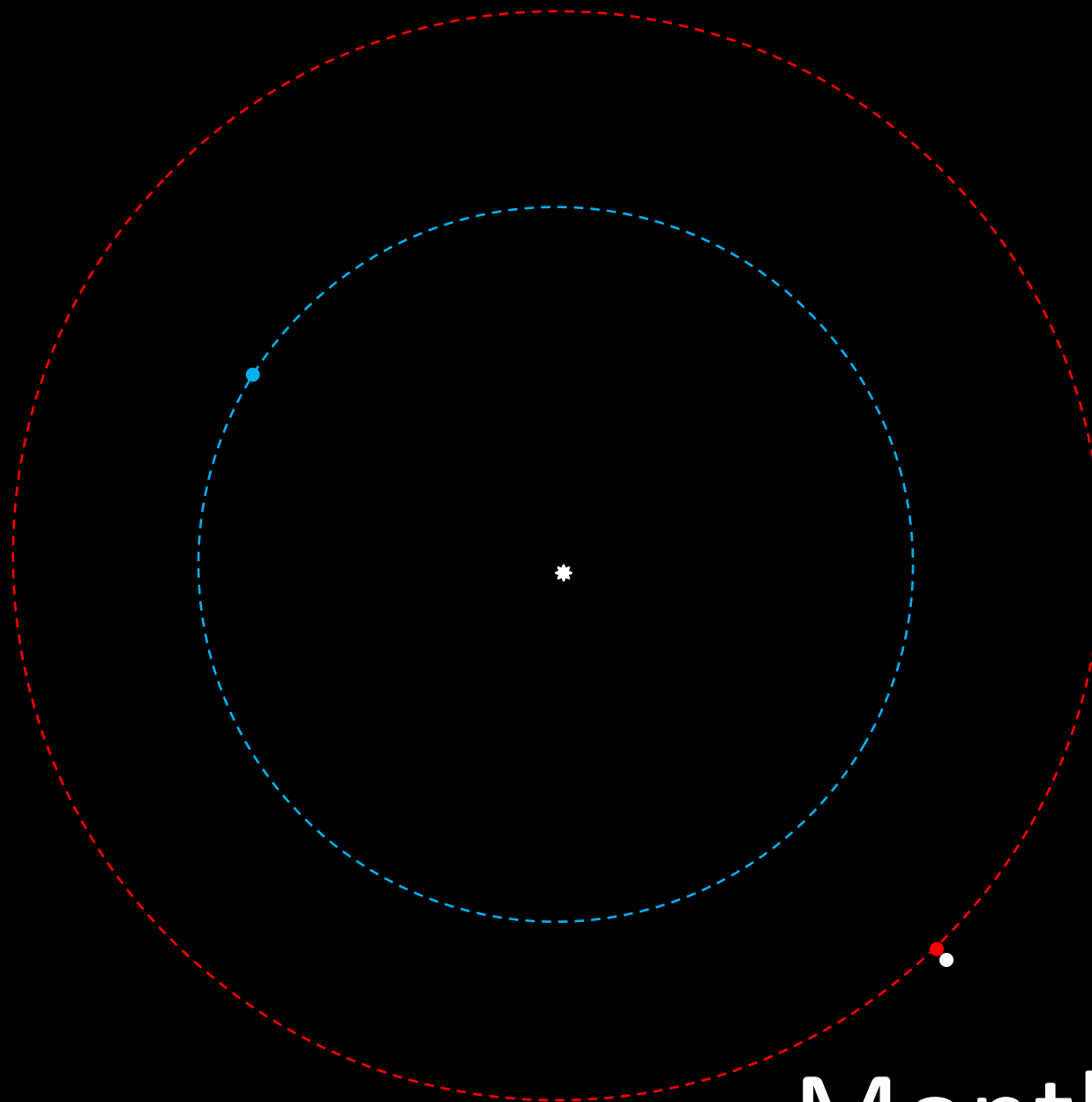
Month 14



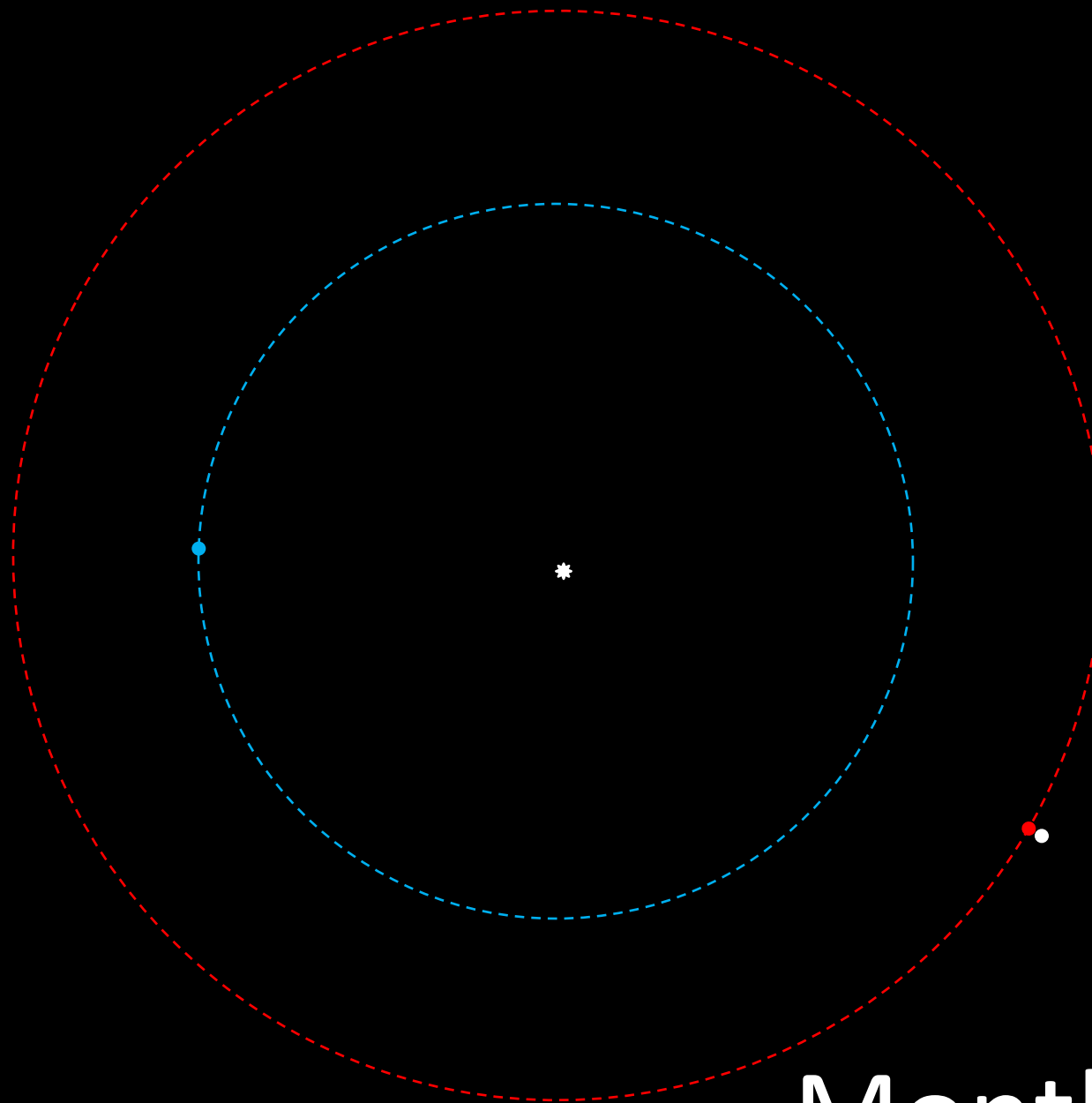
Month 15



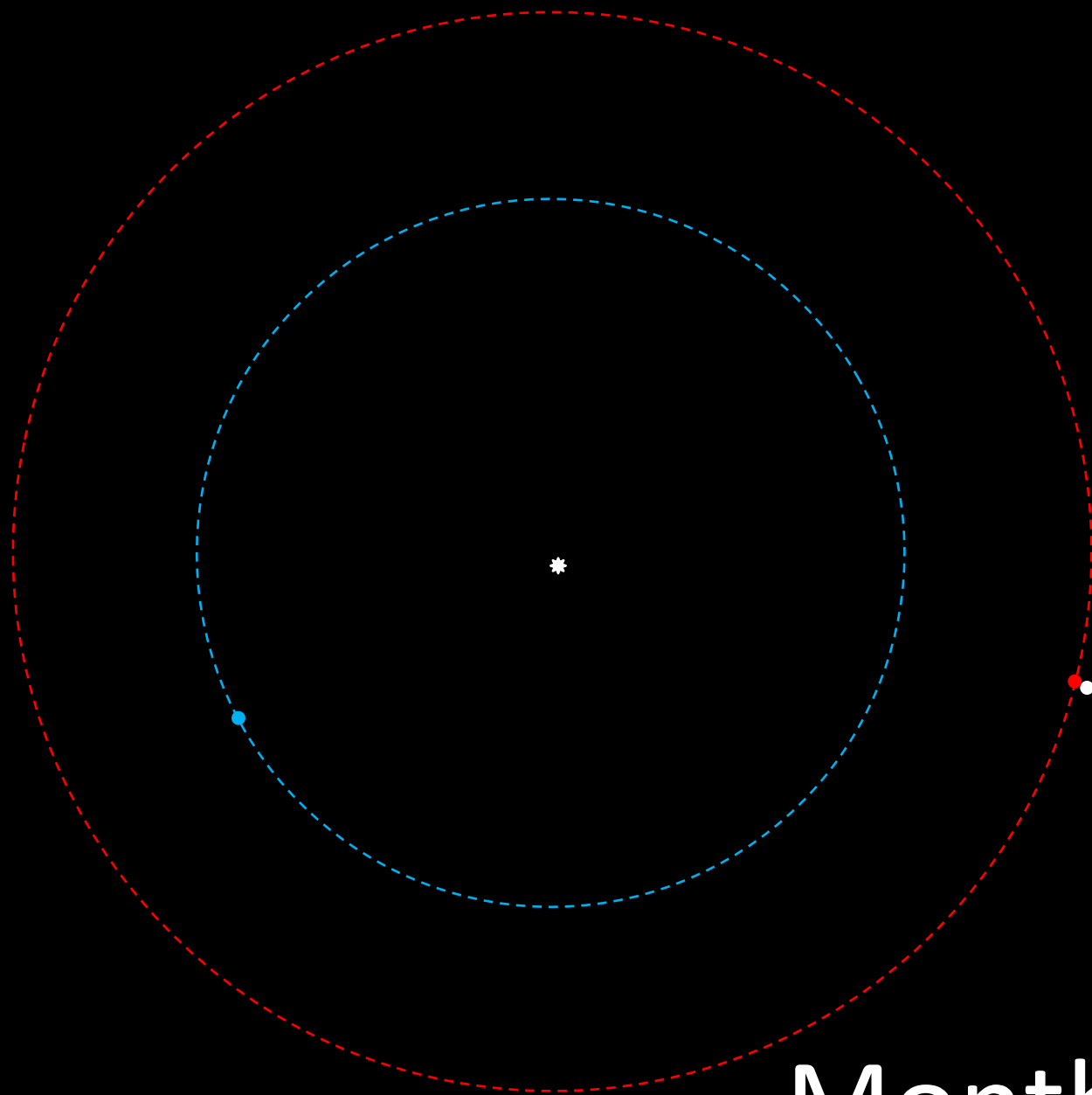
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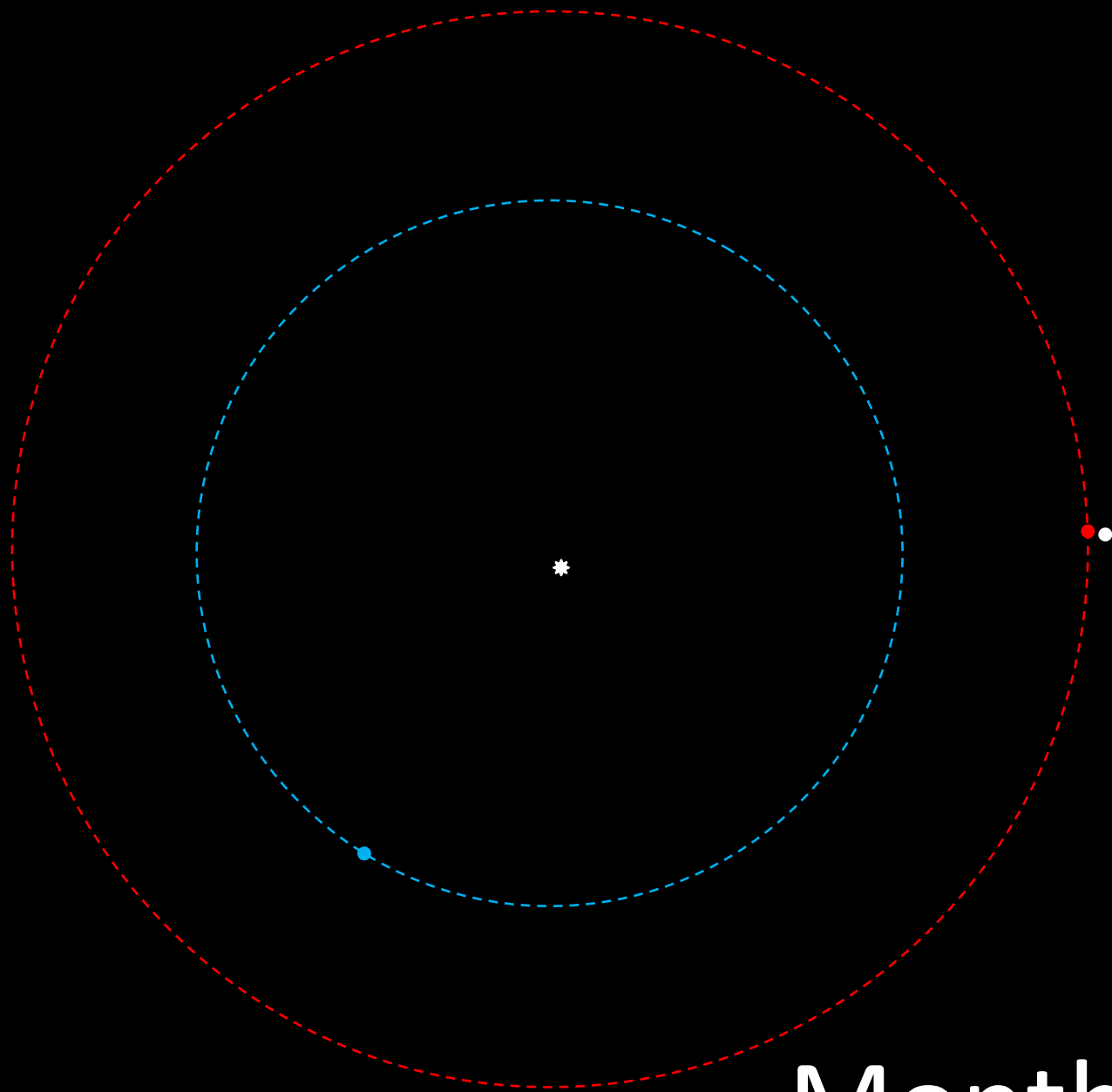
Month 17



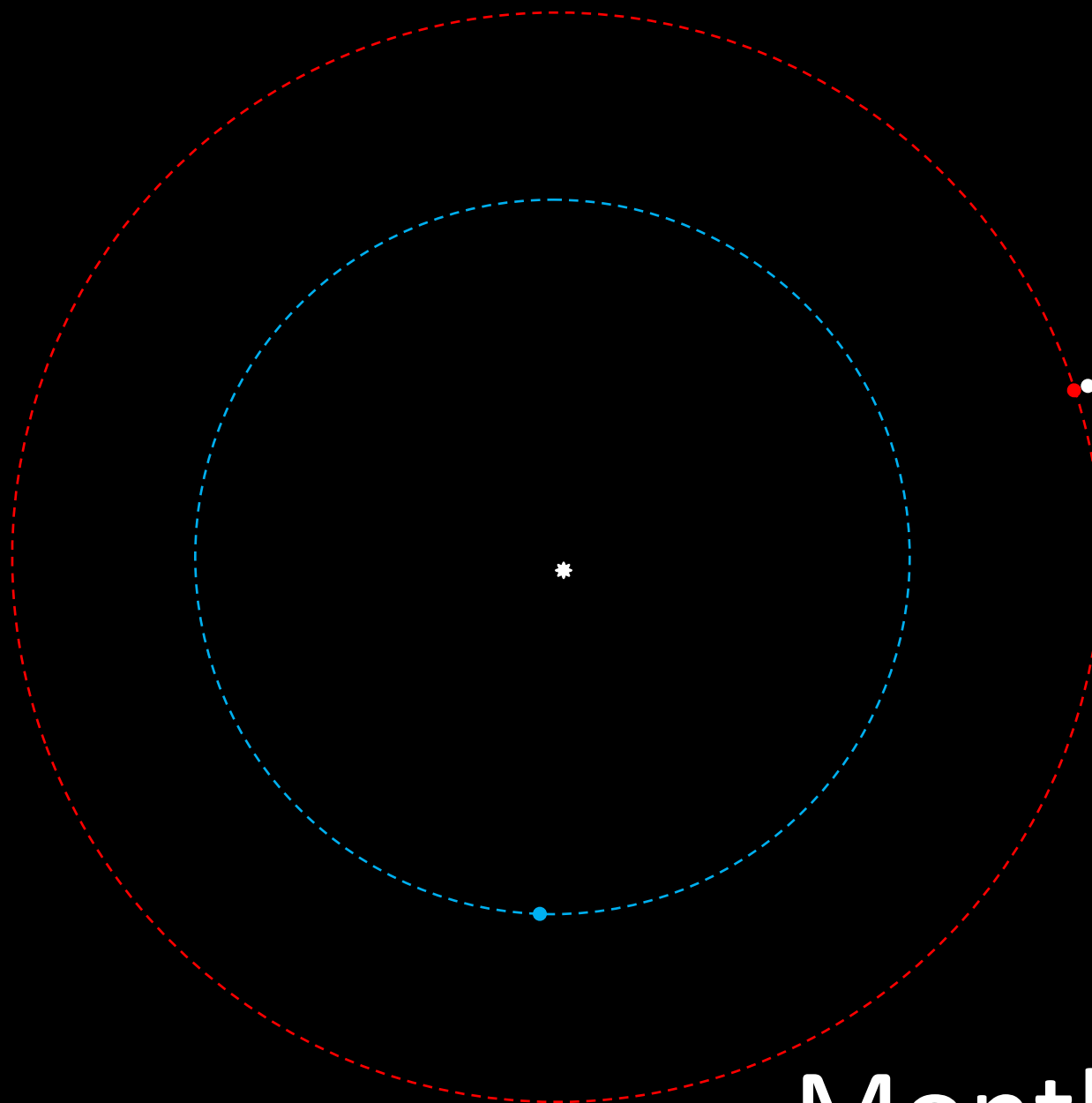
Month 18



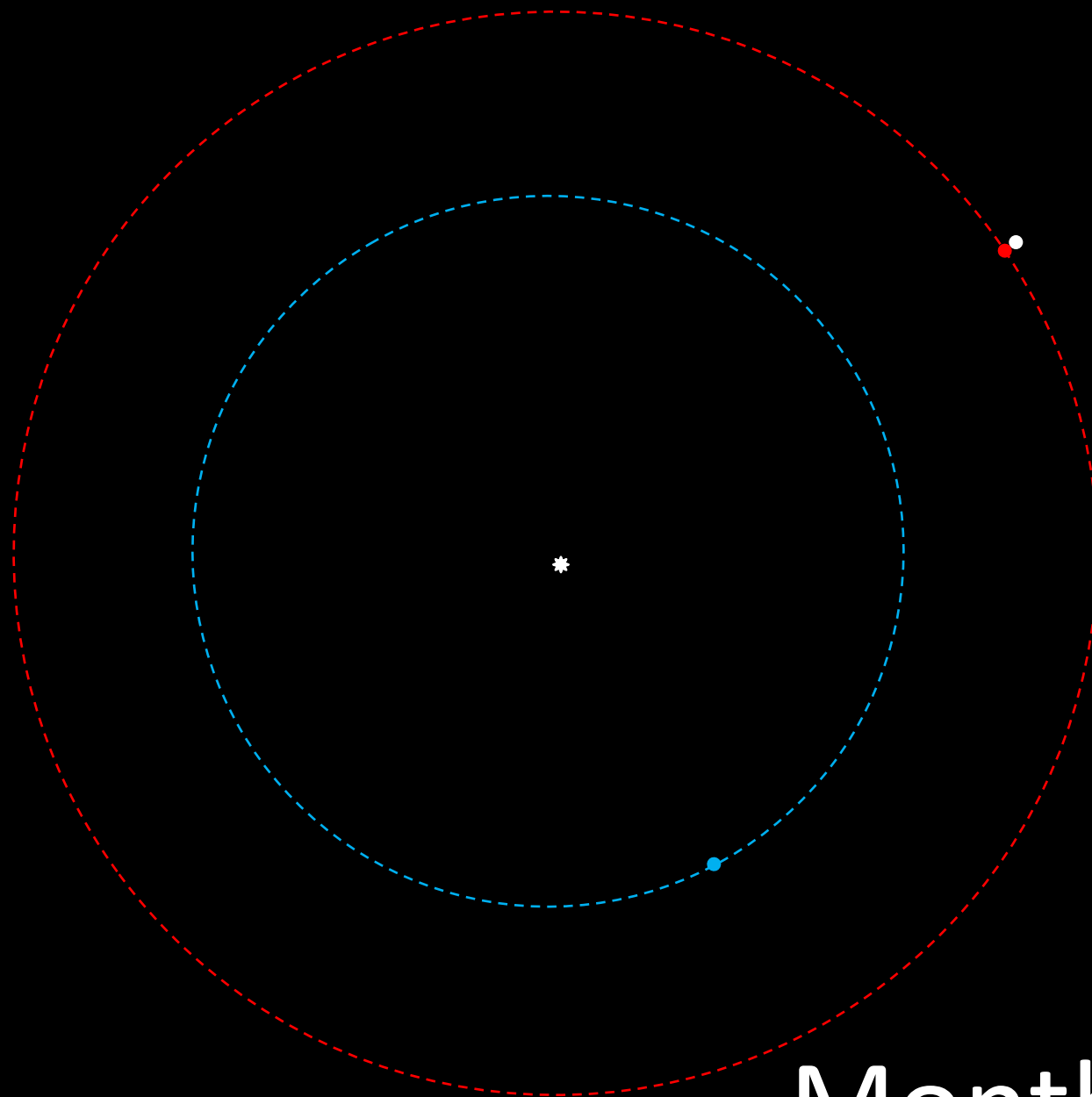
Month 19



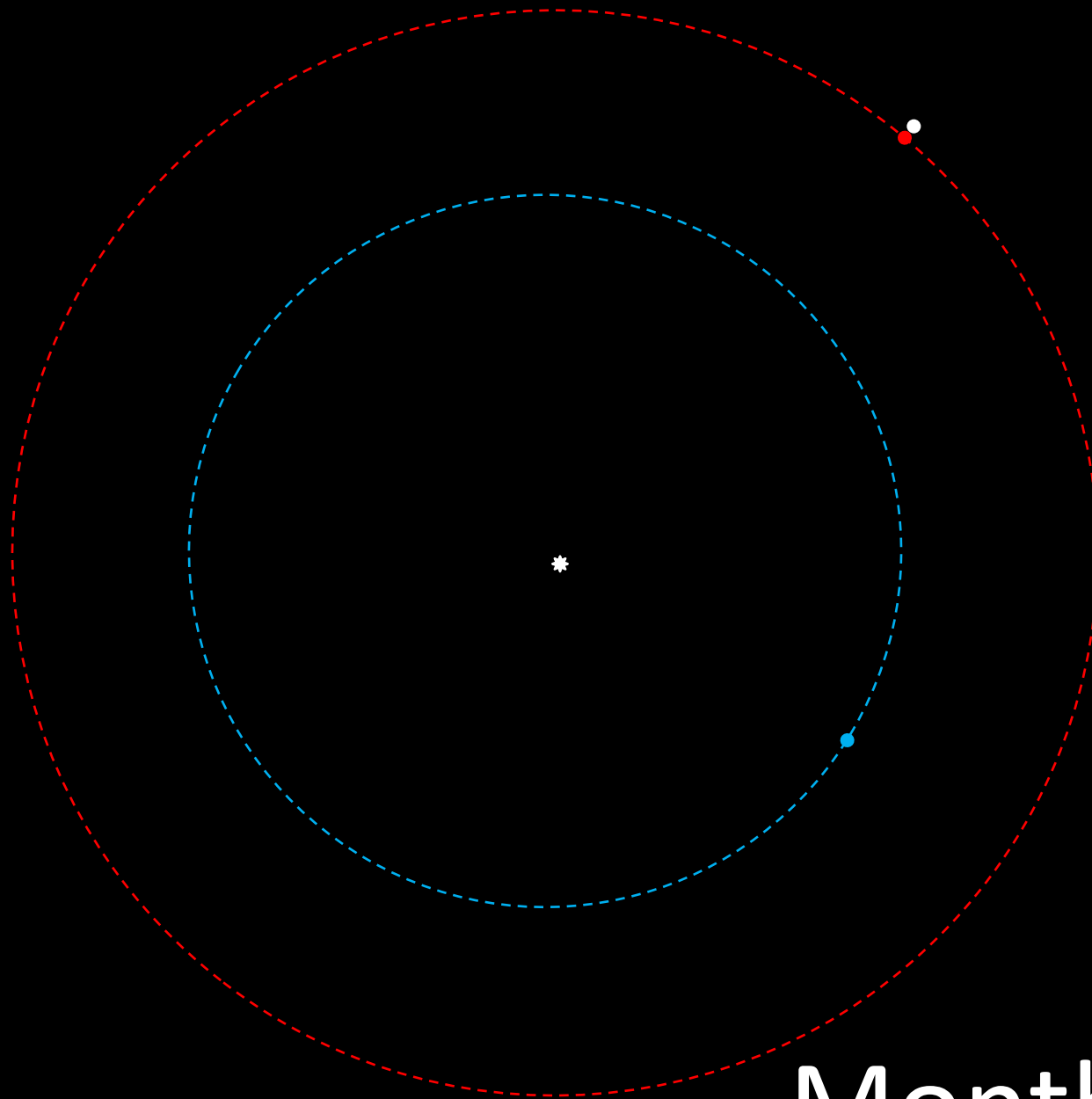
Month 20



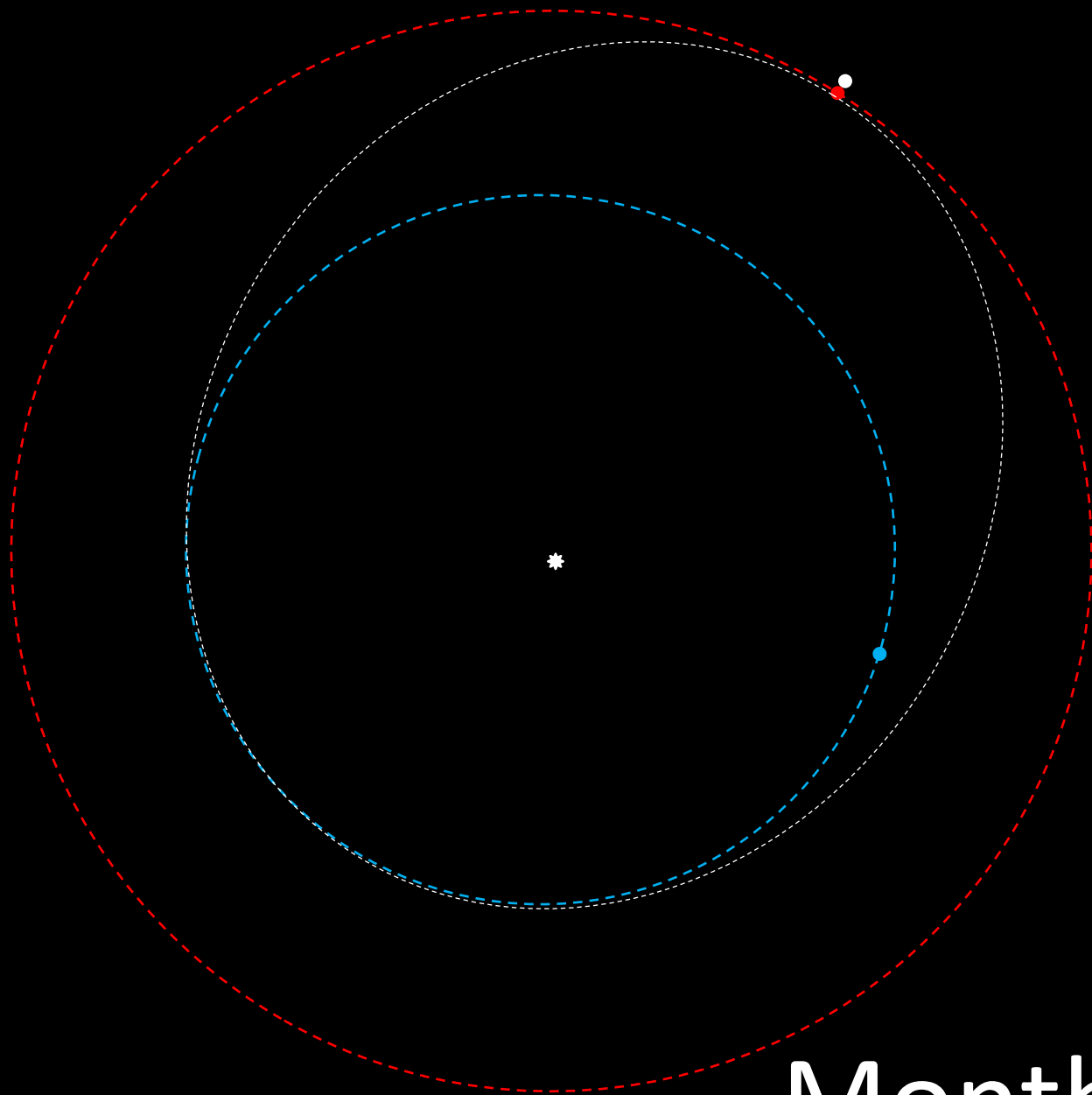
Month 21



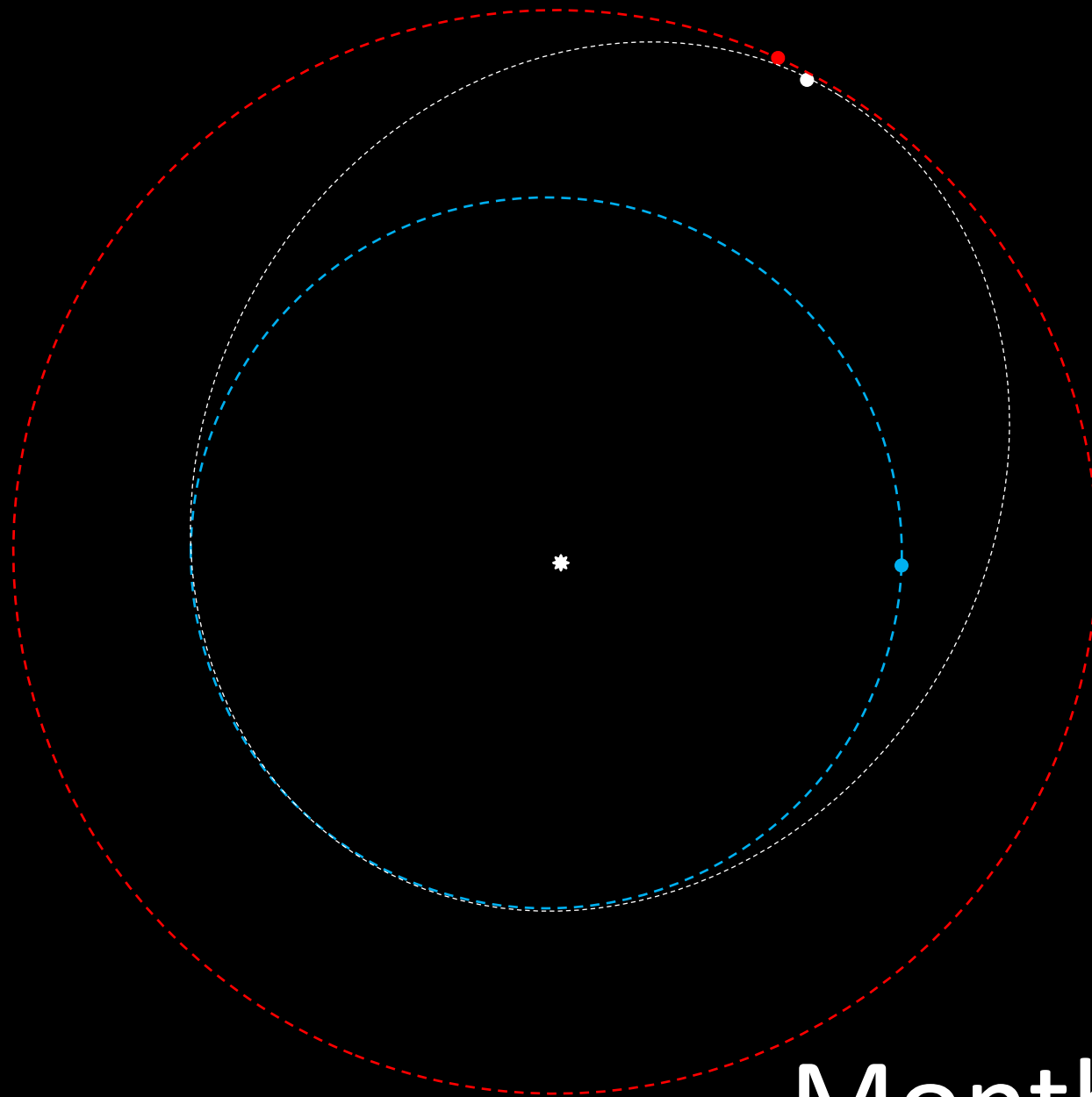
Month 22



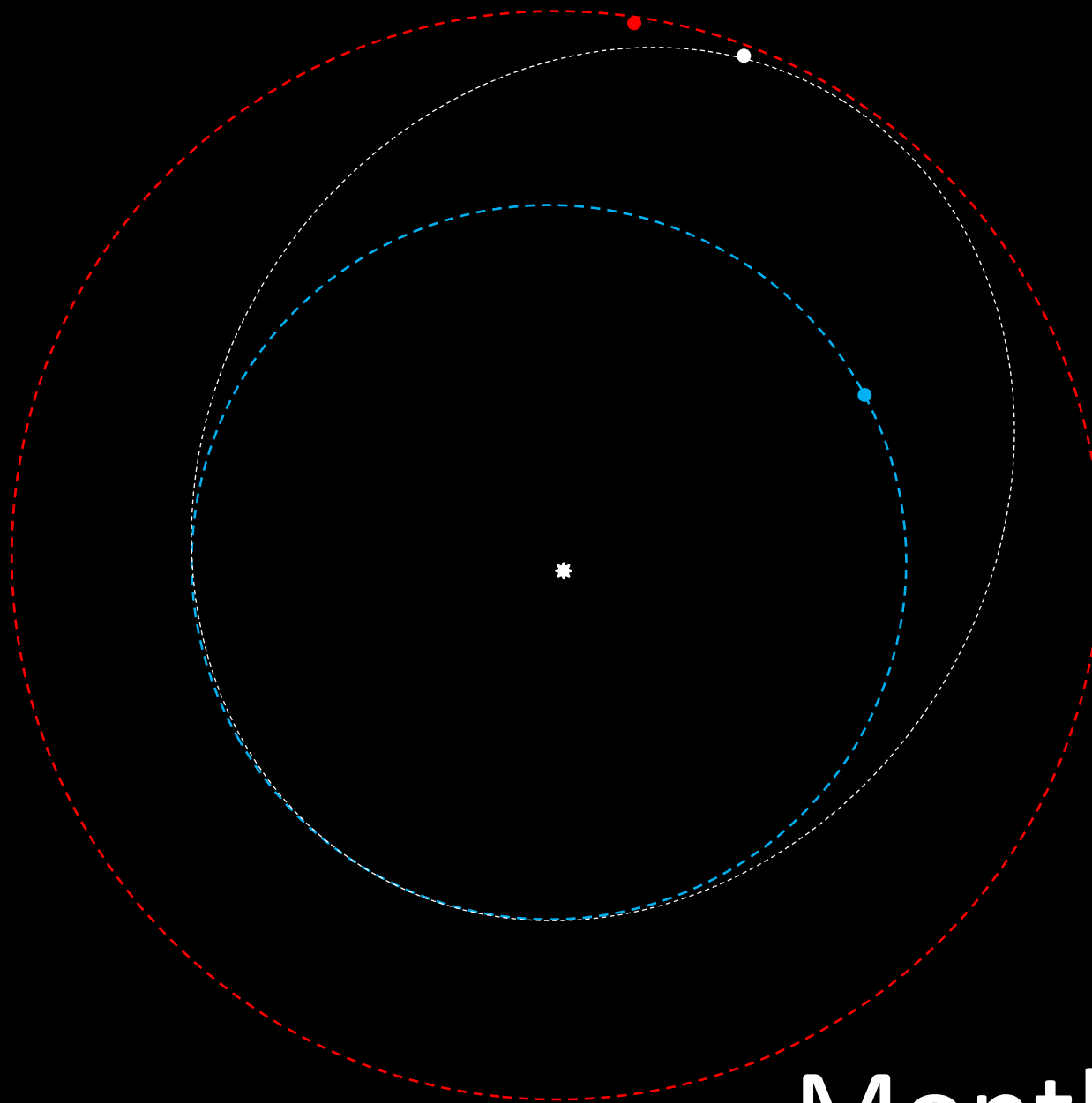
Month 23



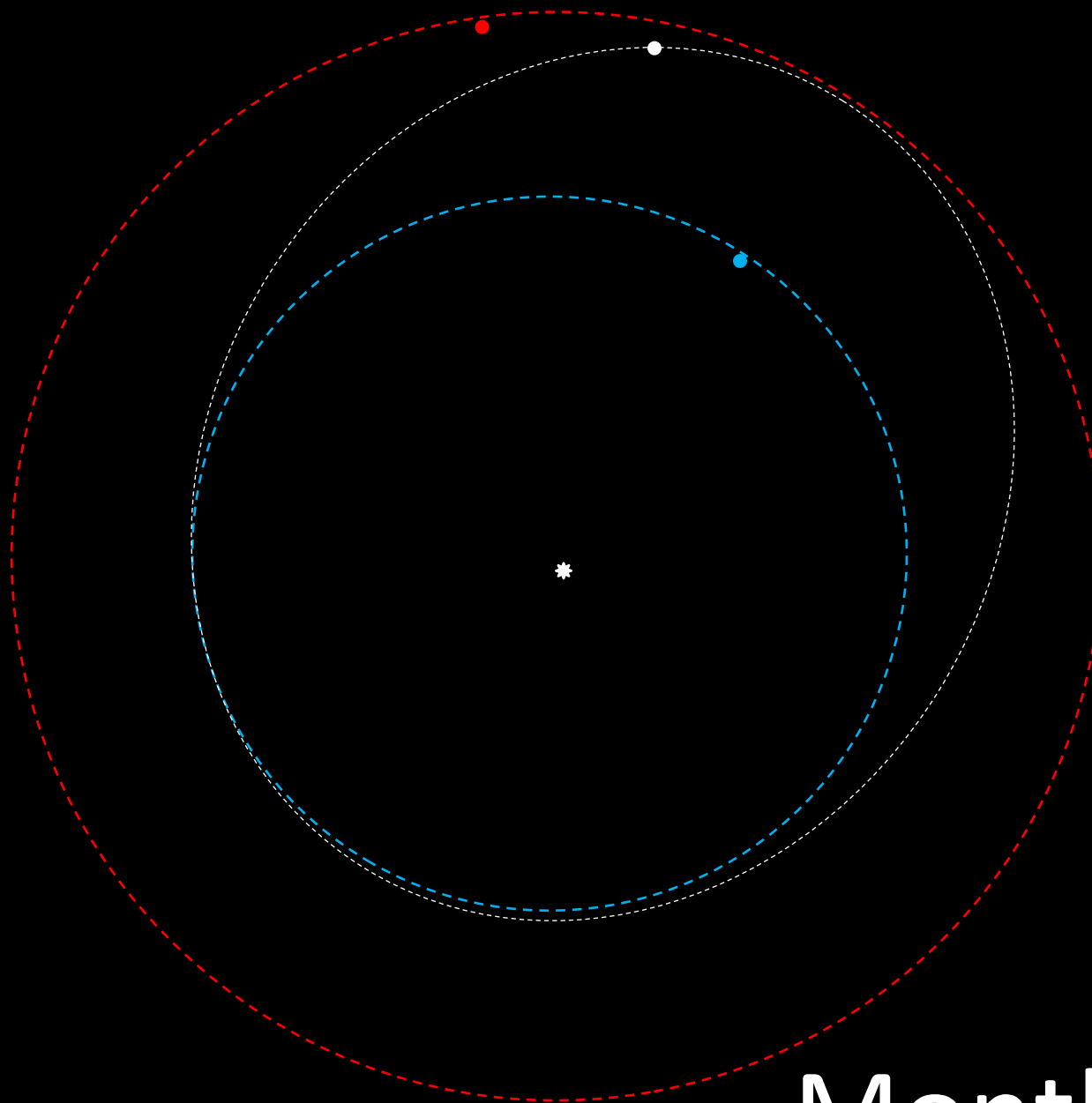
Month 23.5



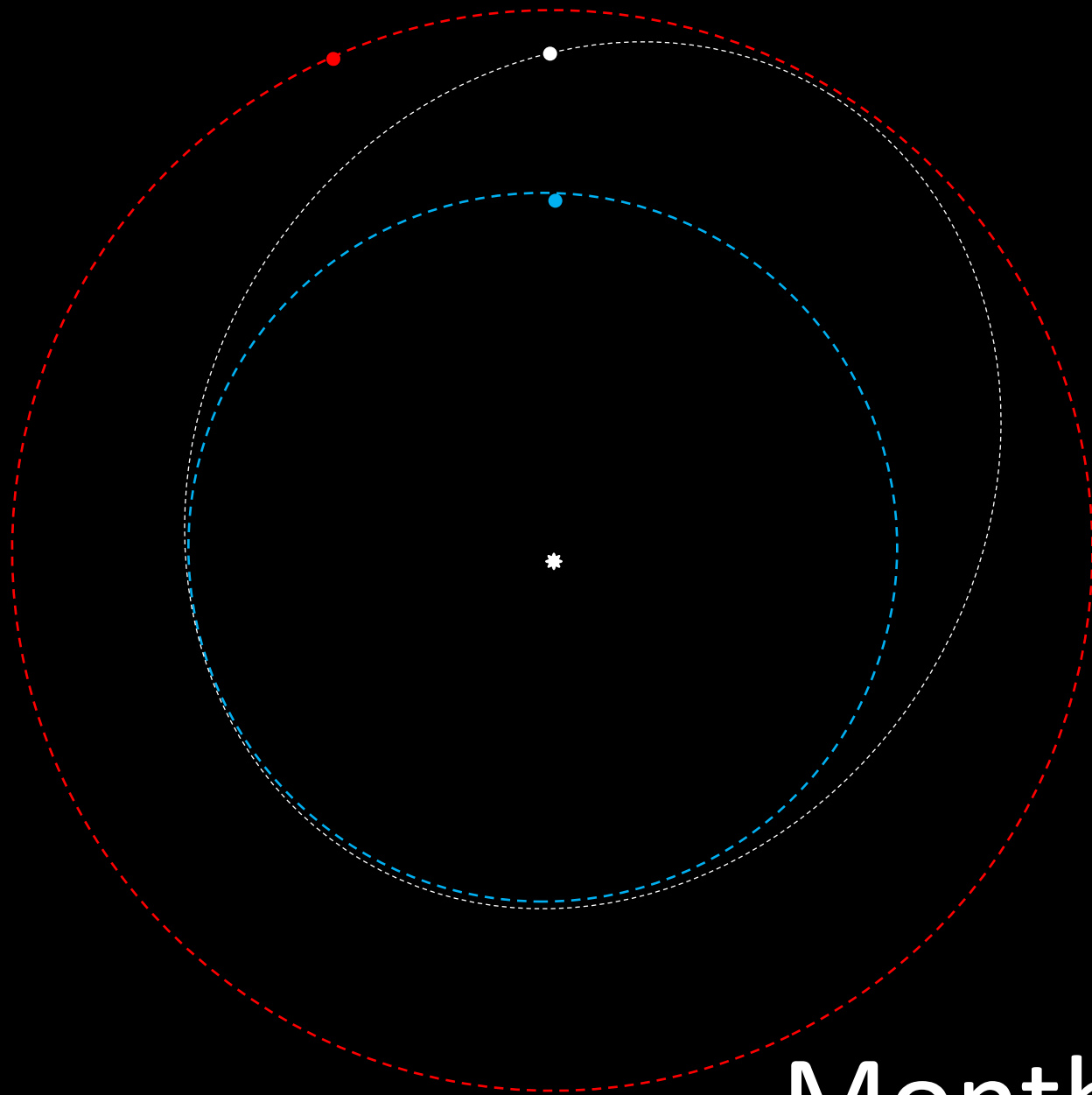
Month 24



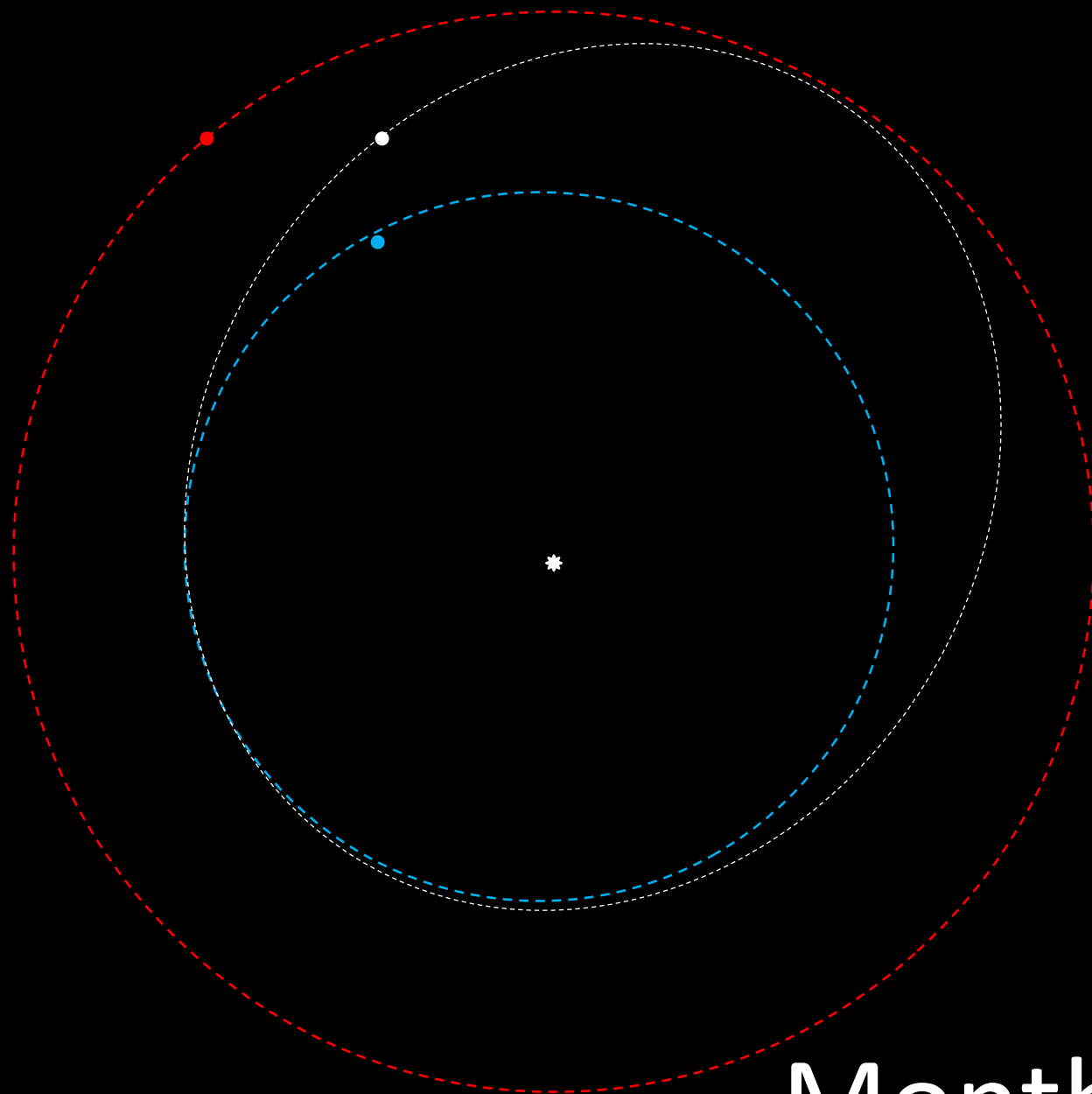
Month 25



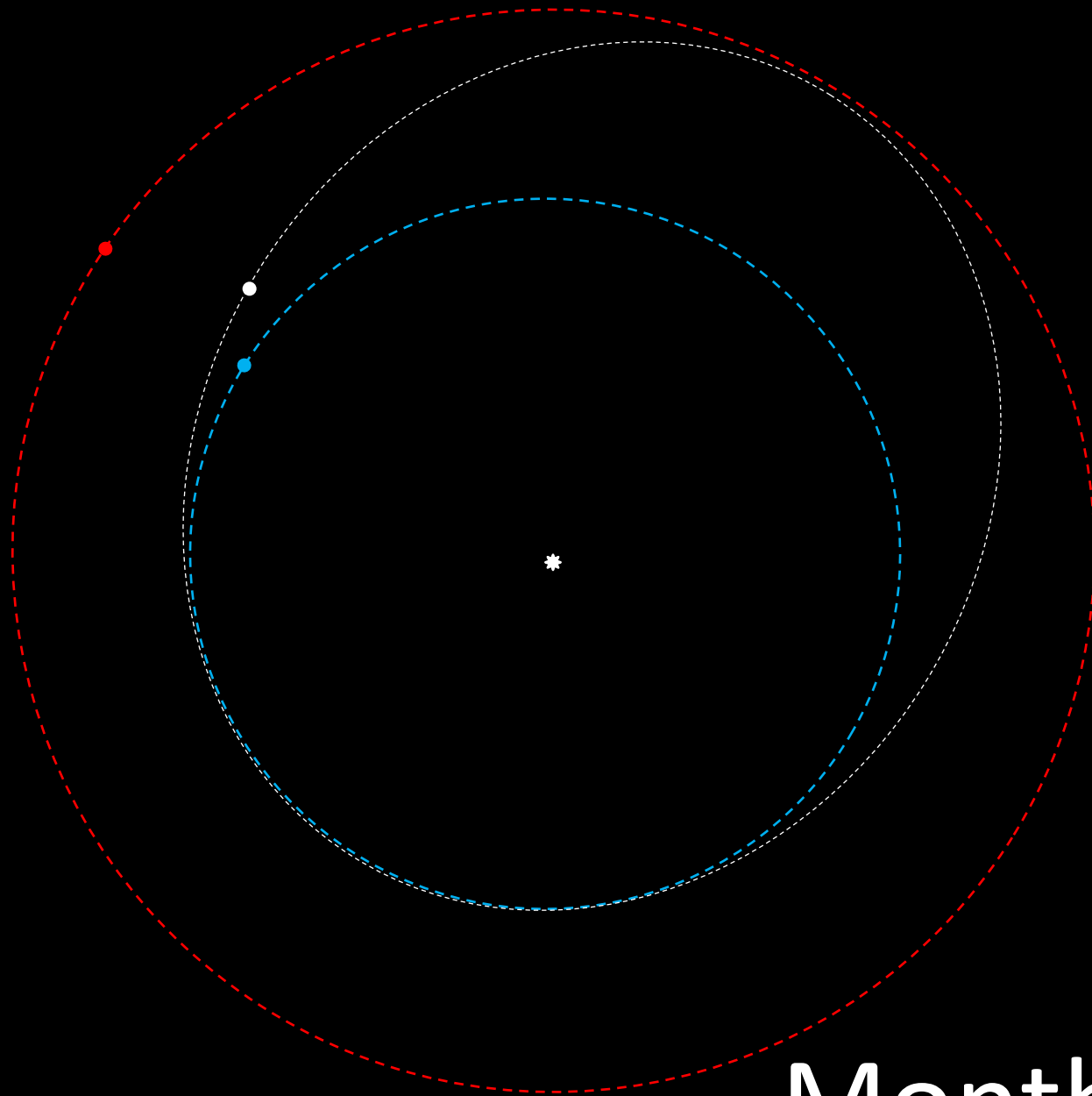
Month 26



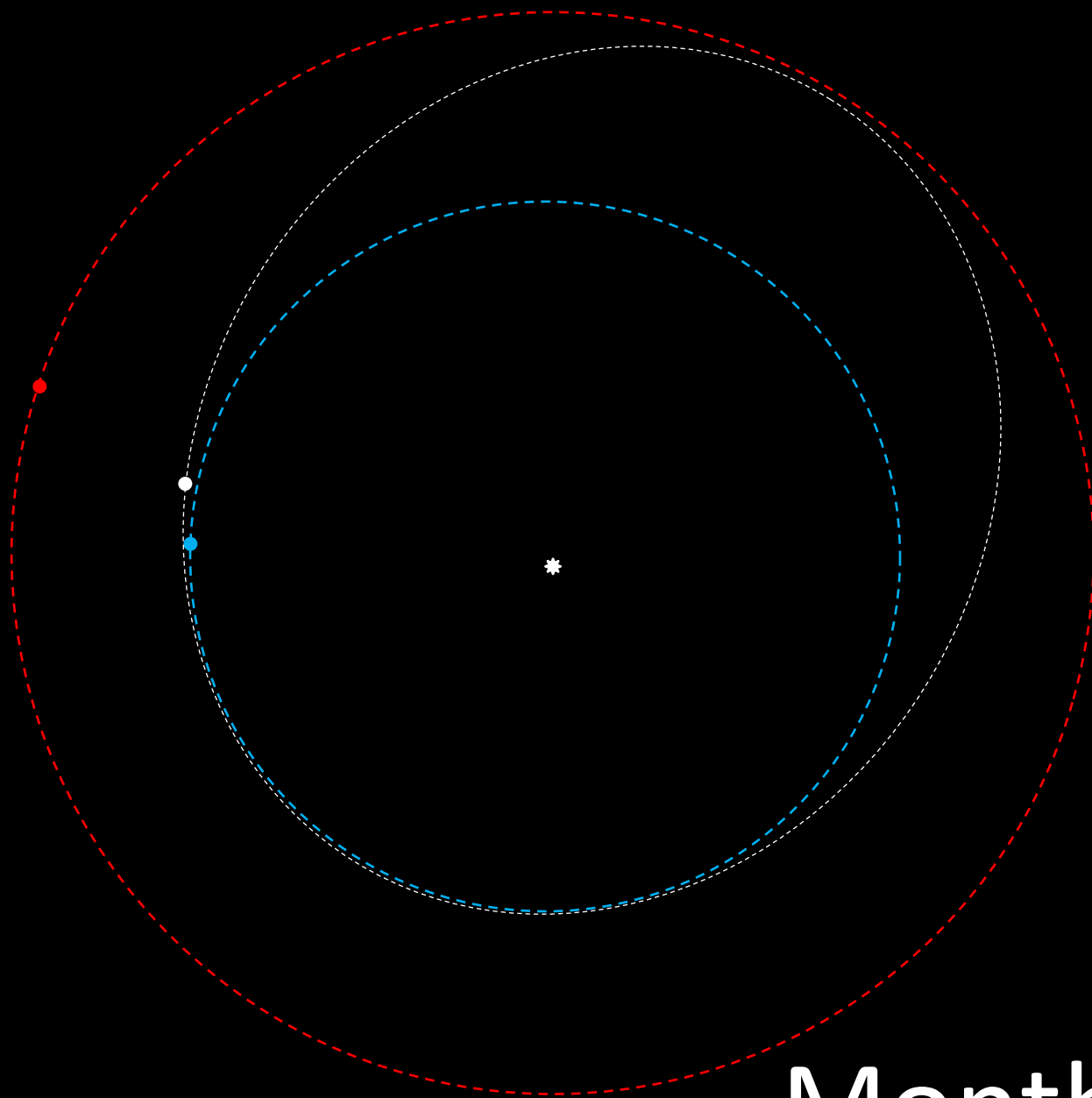
Month 27



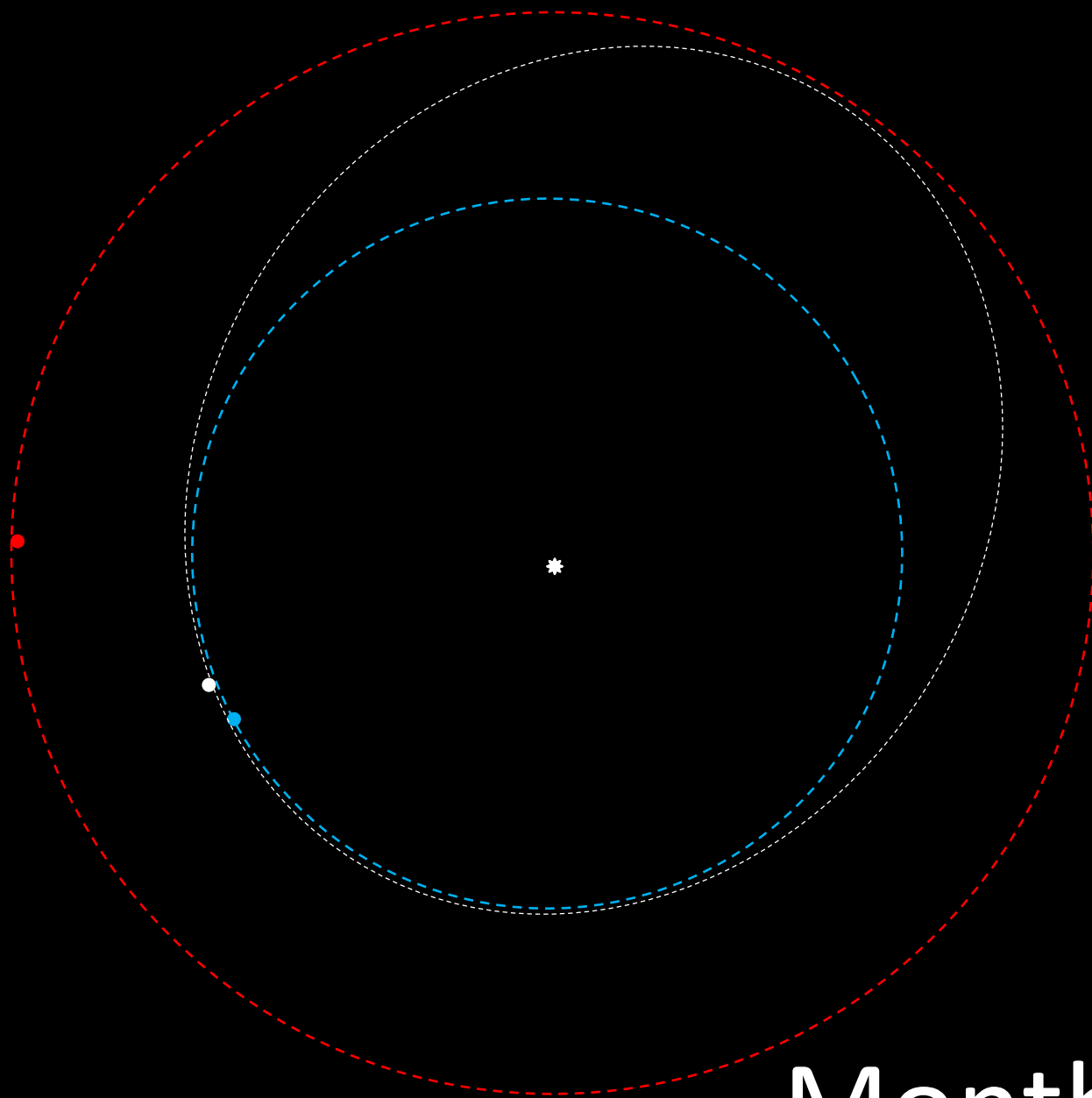
Month 28



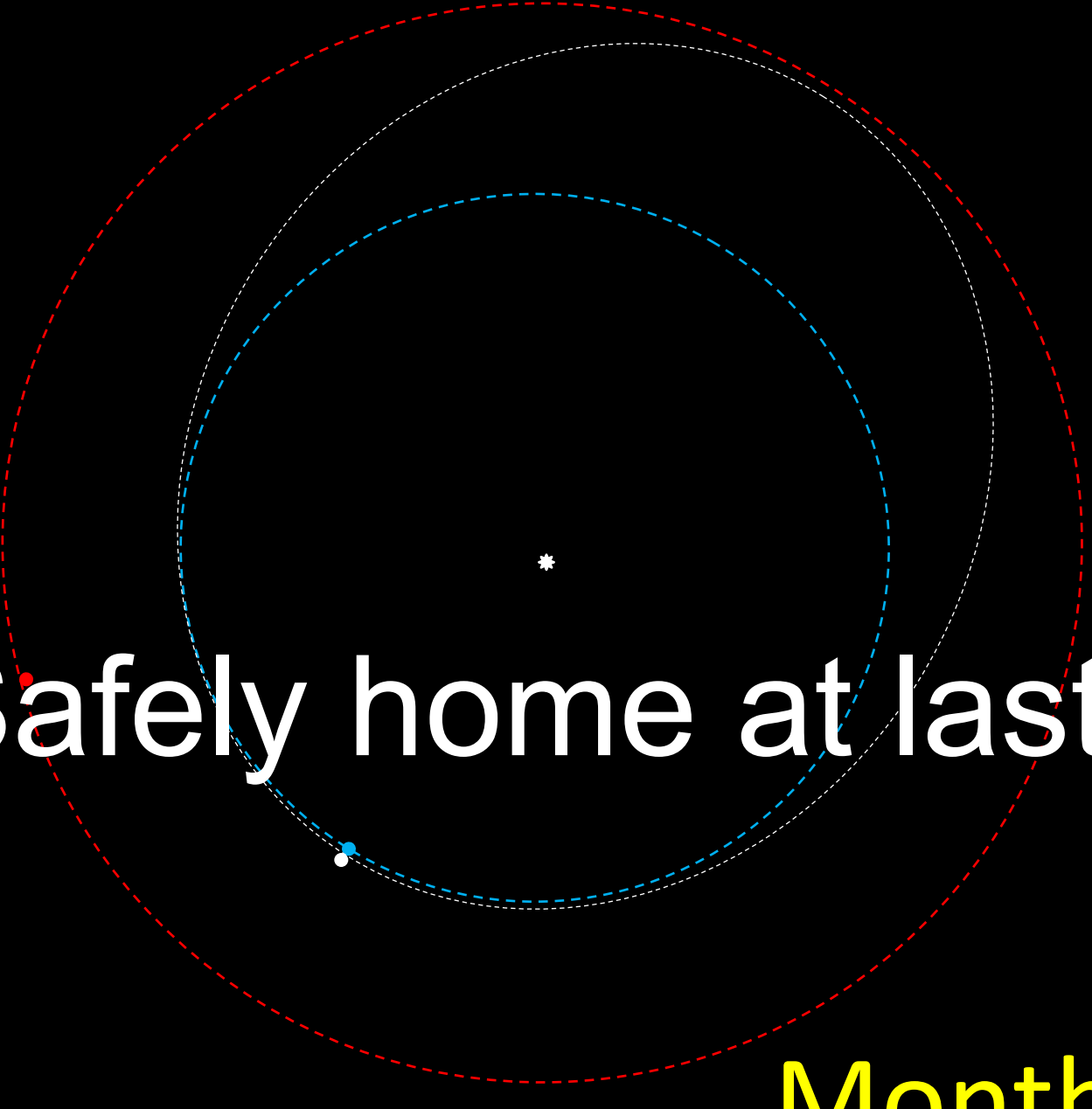
Month 29



Month 30

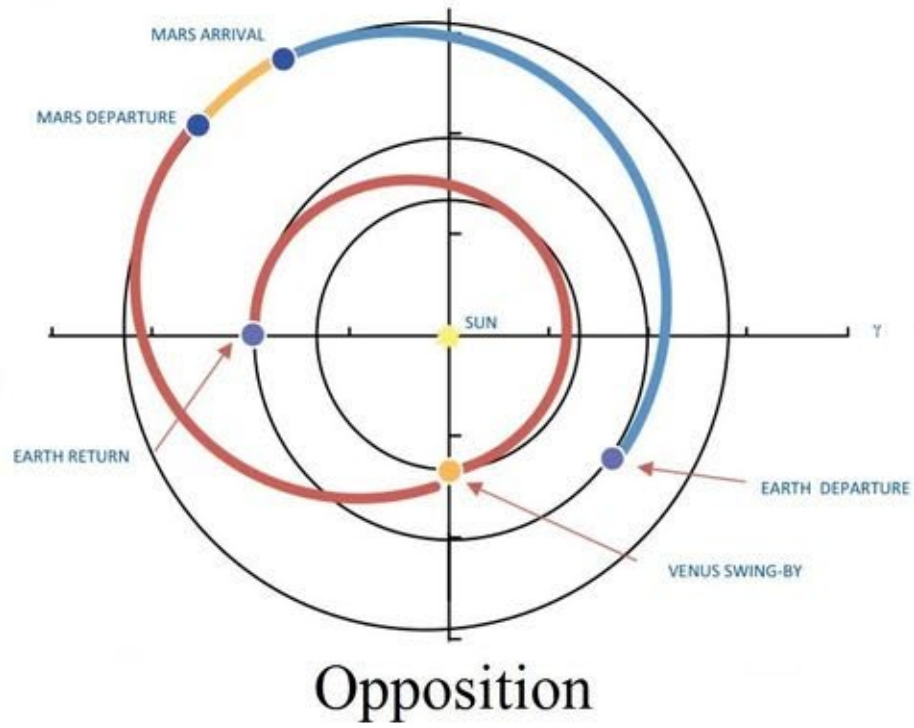
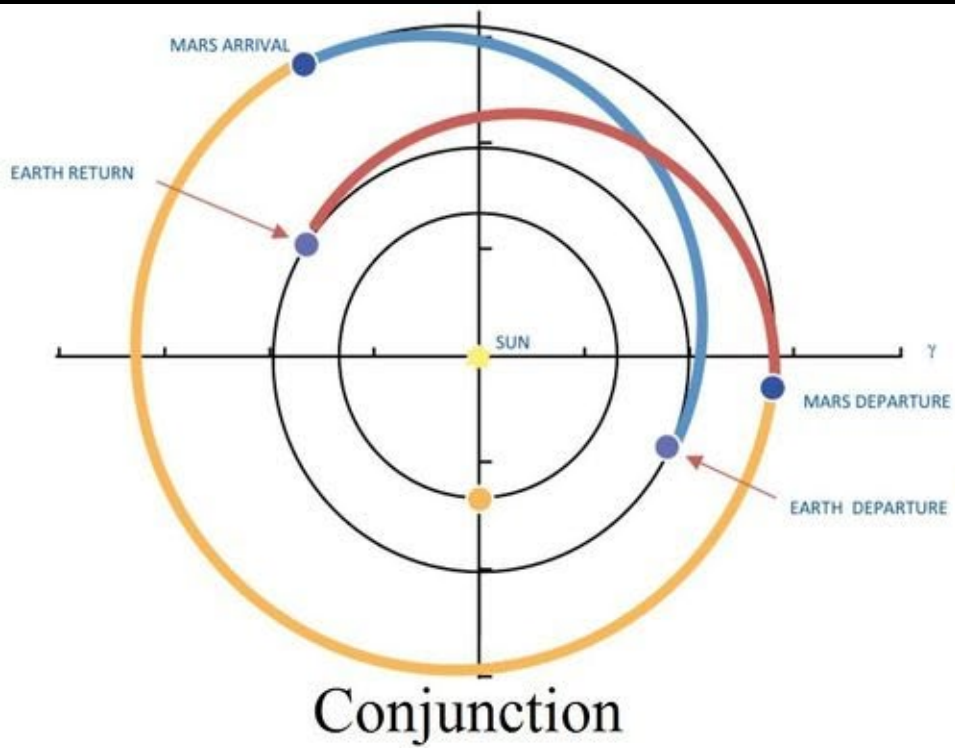


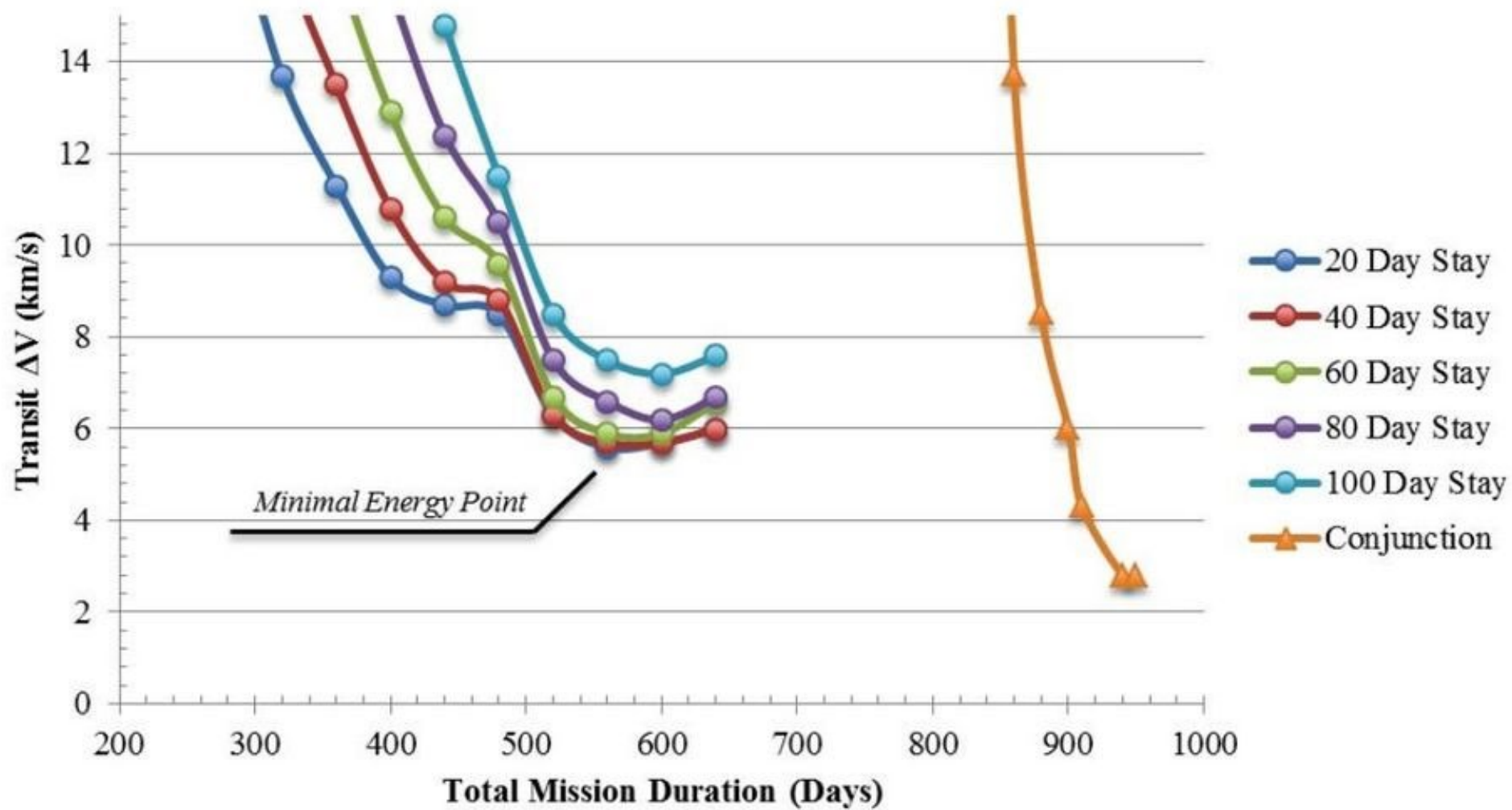
Month 31

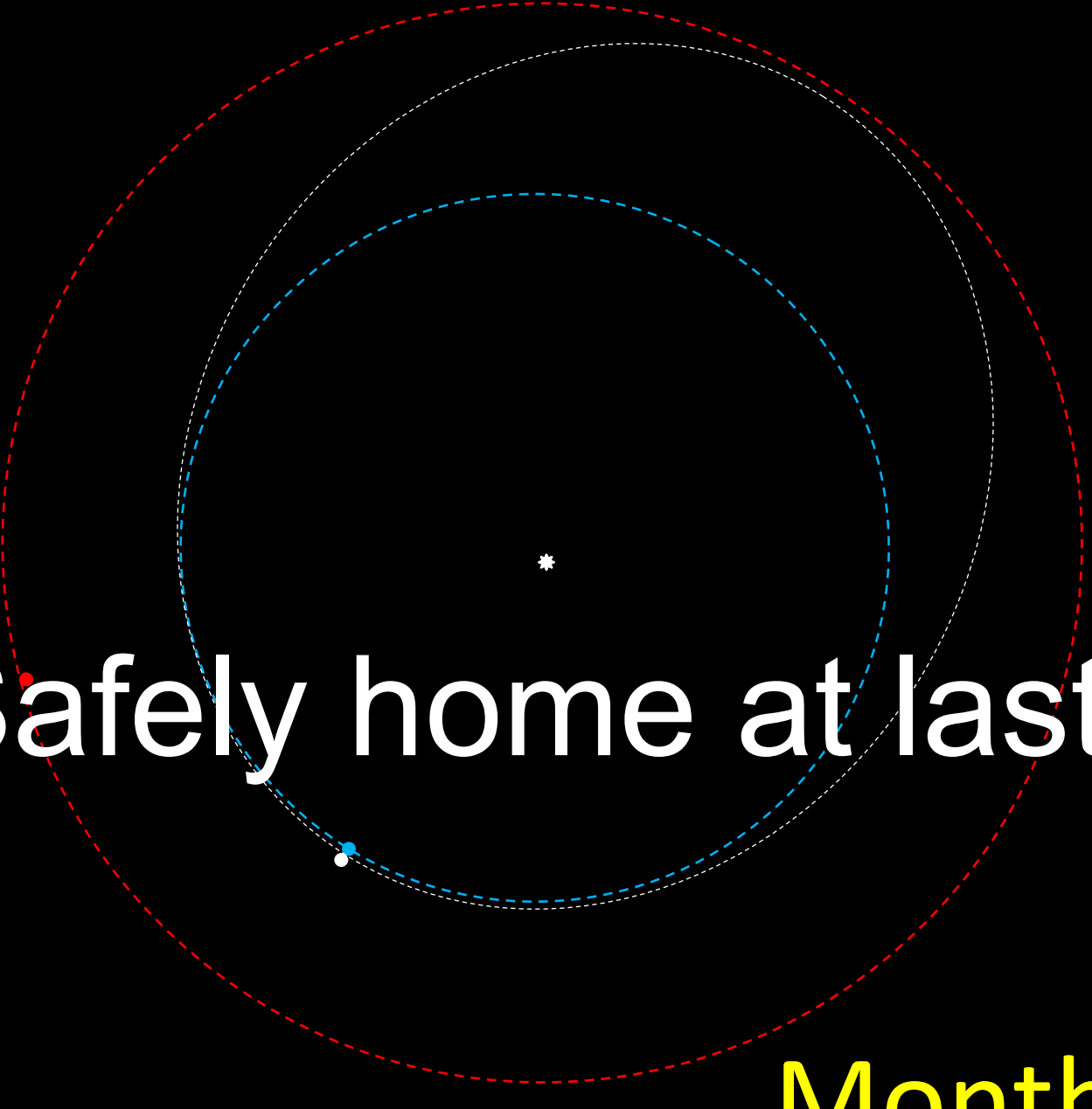


Safely home at last!

Month 32







Safely home at last!

Month 32

?



+

+



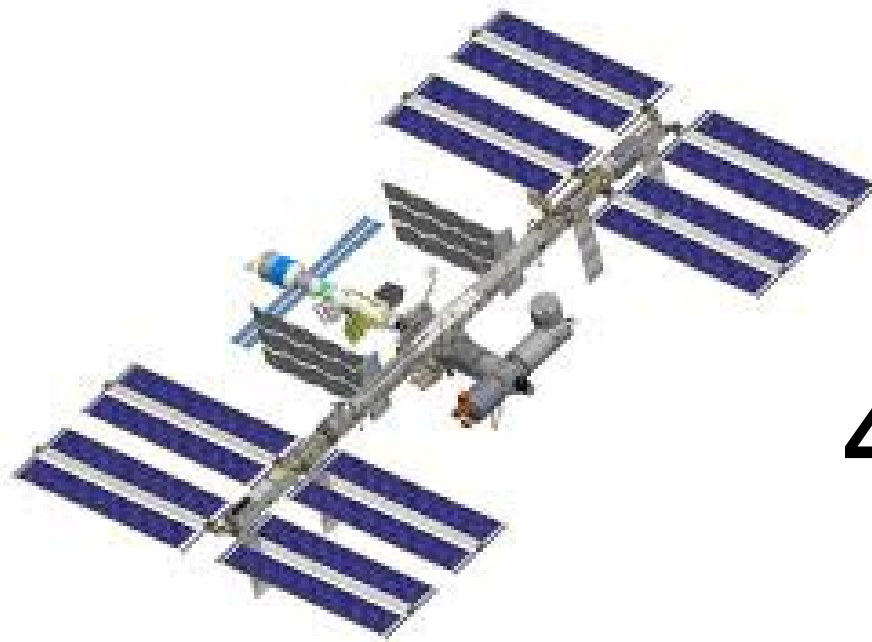
+



×9,150

×1,180

×280



420 tons



+

+



+



×9,150

×1,180

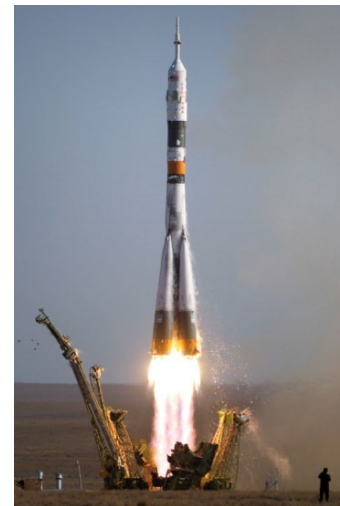
×280



+



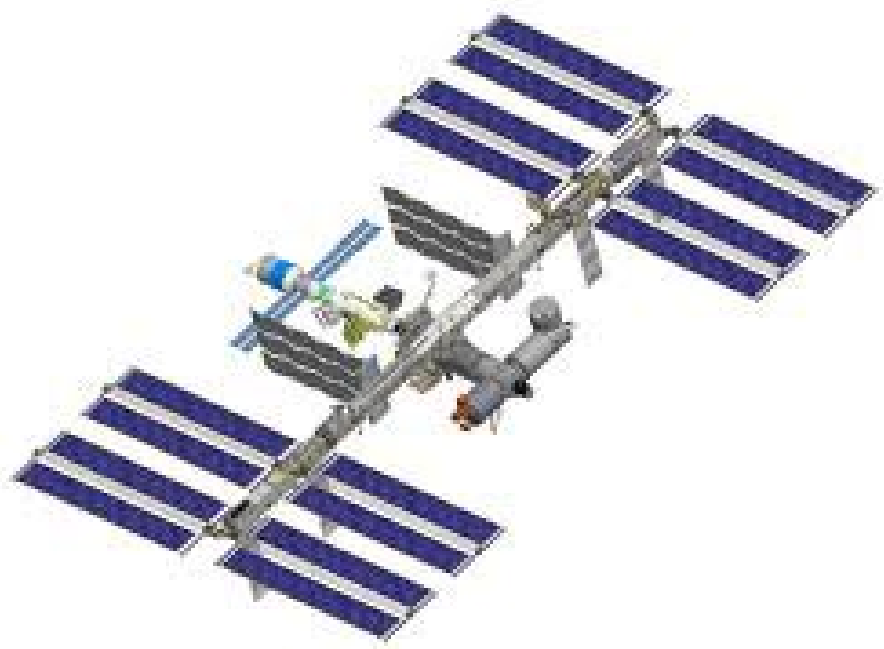
+



×27

×2

×2



420 tons



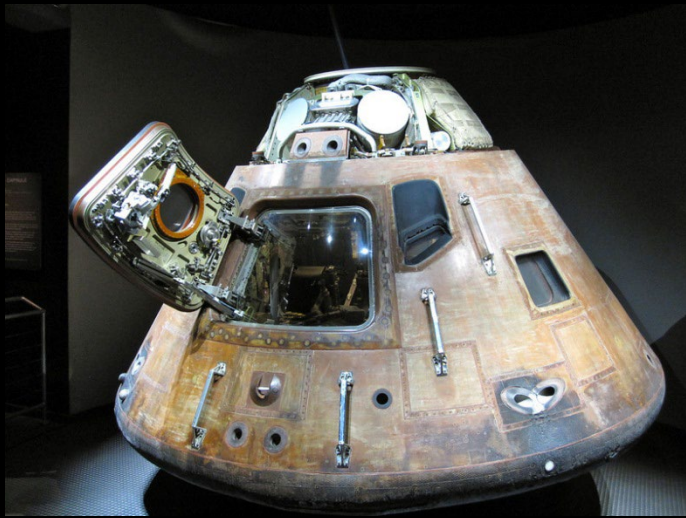
RECYCLE





100 tons

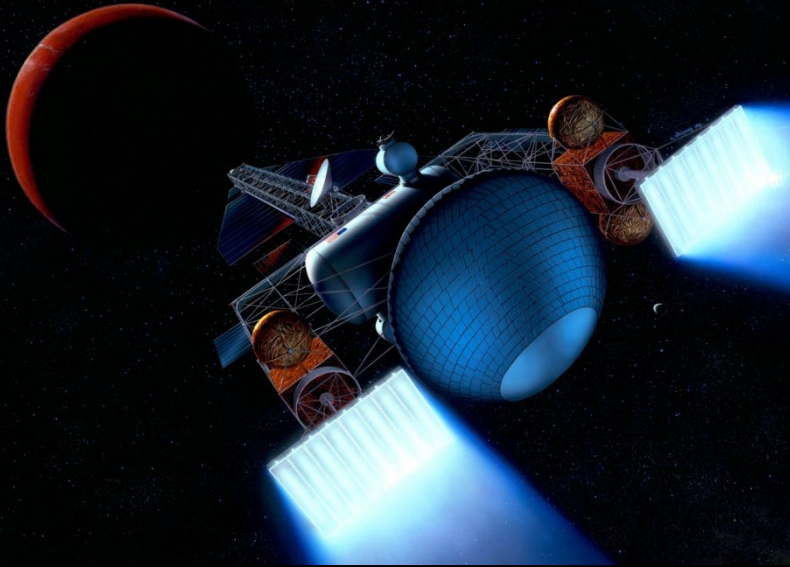




6 tons



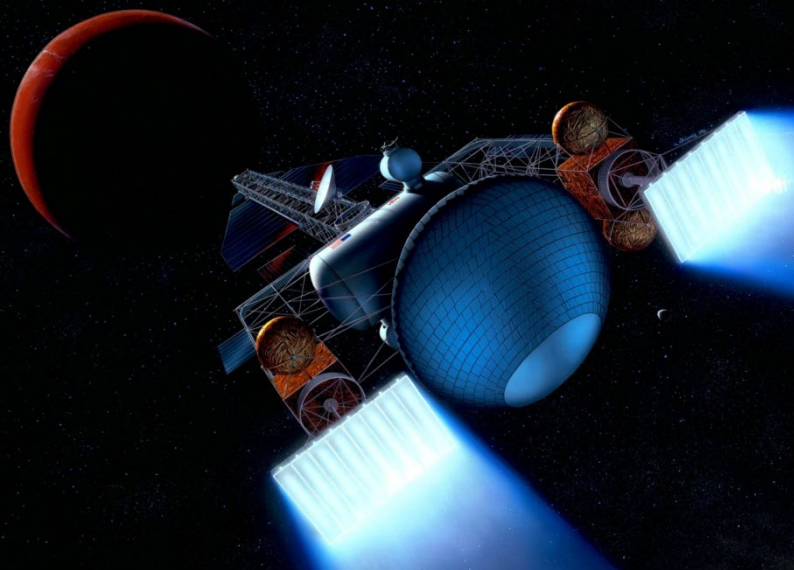
3,350 tons



100 tons

?

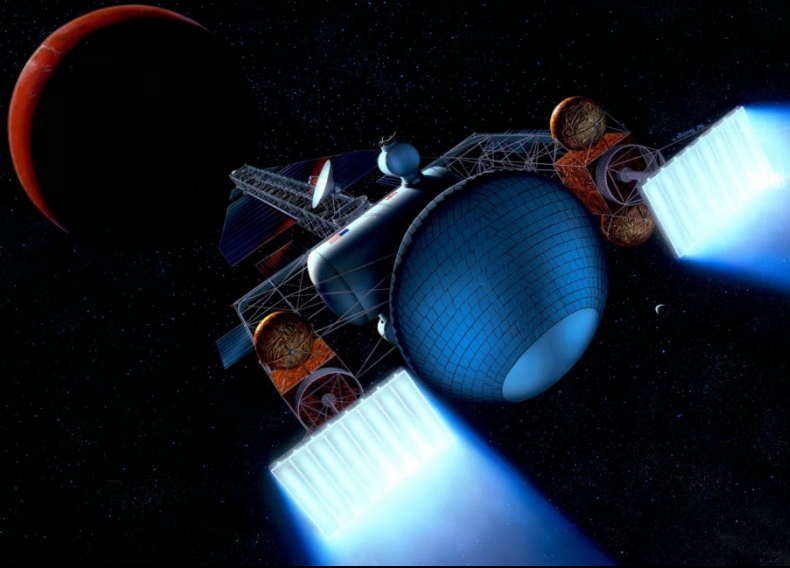
85,000 tons



100 tons



85,000 tons

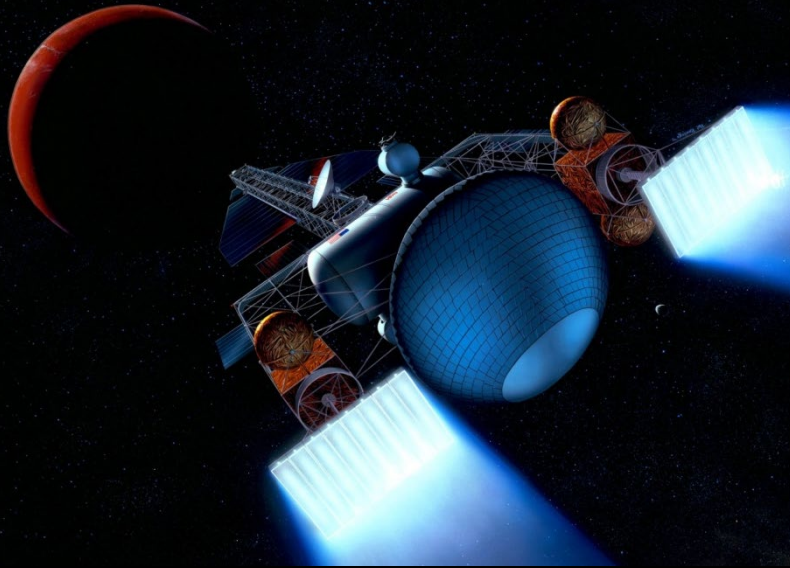


100 tons



× 39

85,000 tons

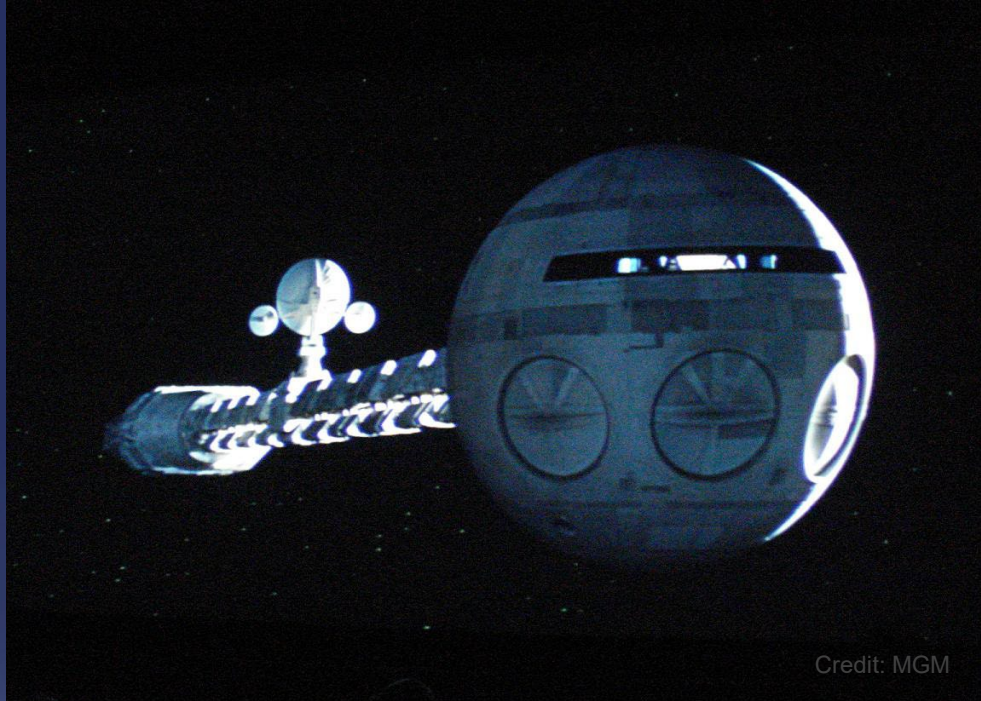


100 tons

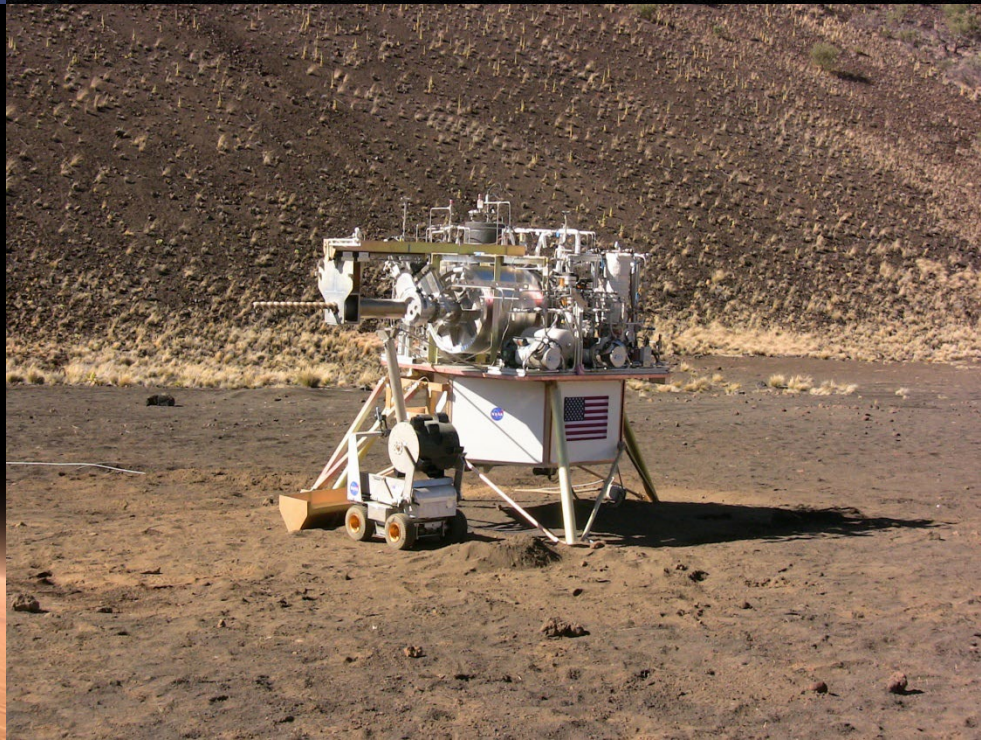
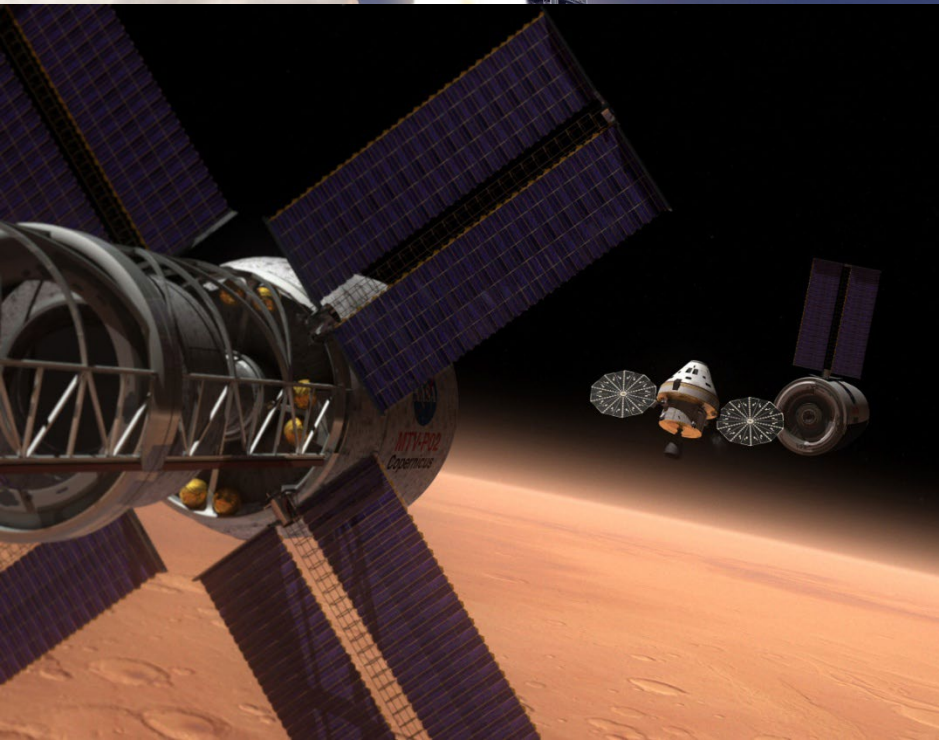


× 25

85,000 tons



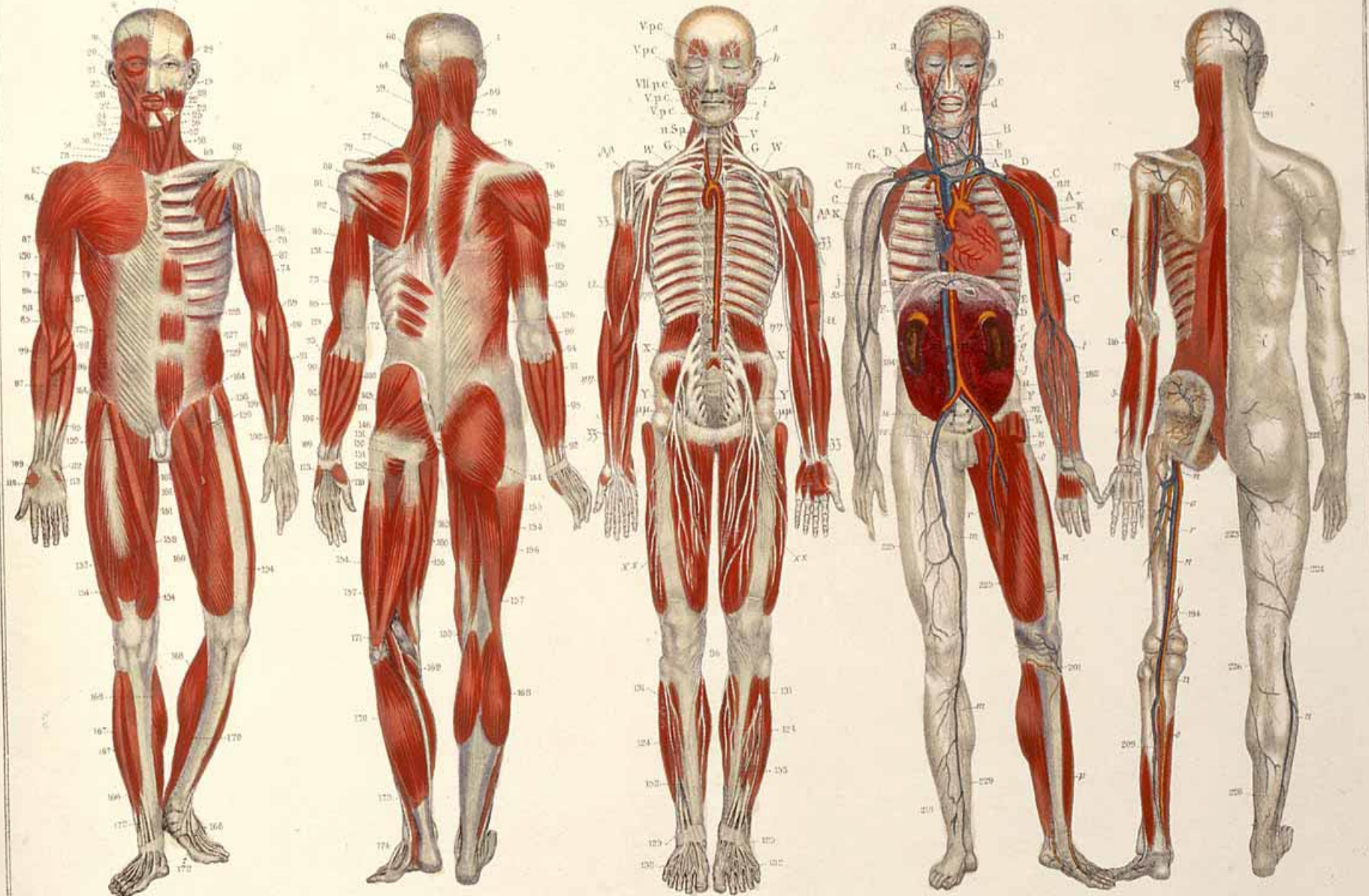
Credit: MGM



Myography.

Neurography.

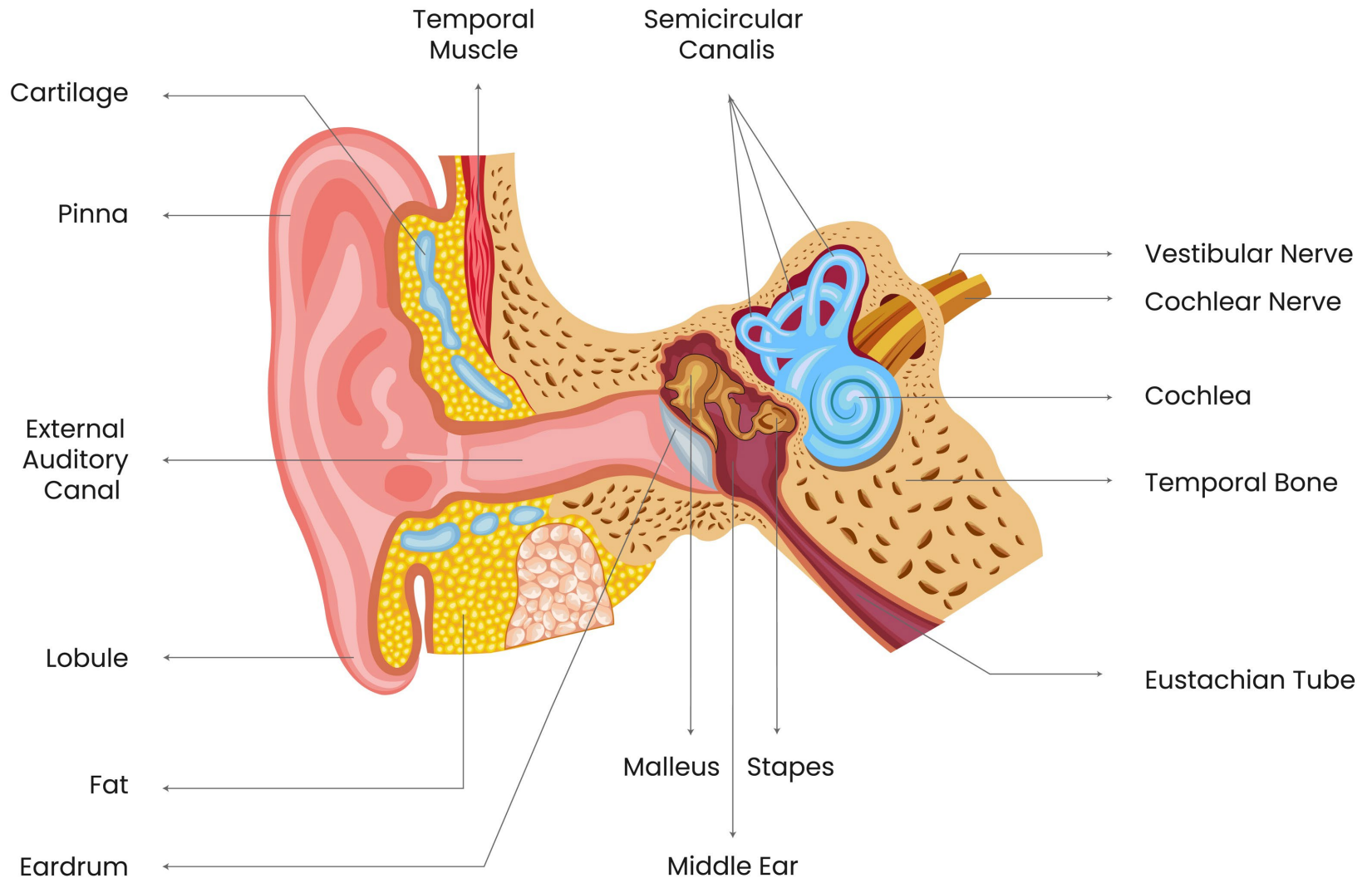
Angeography.

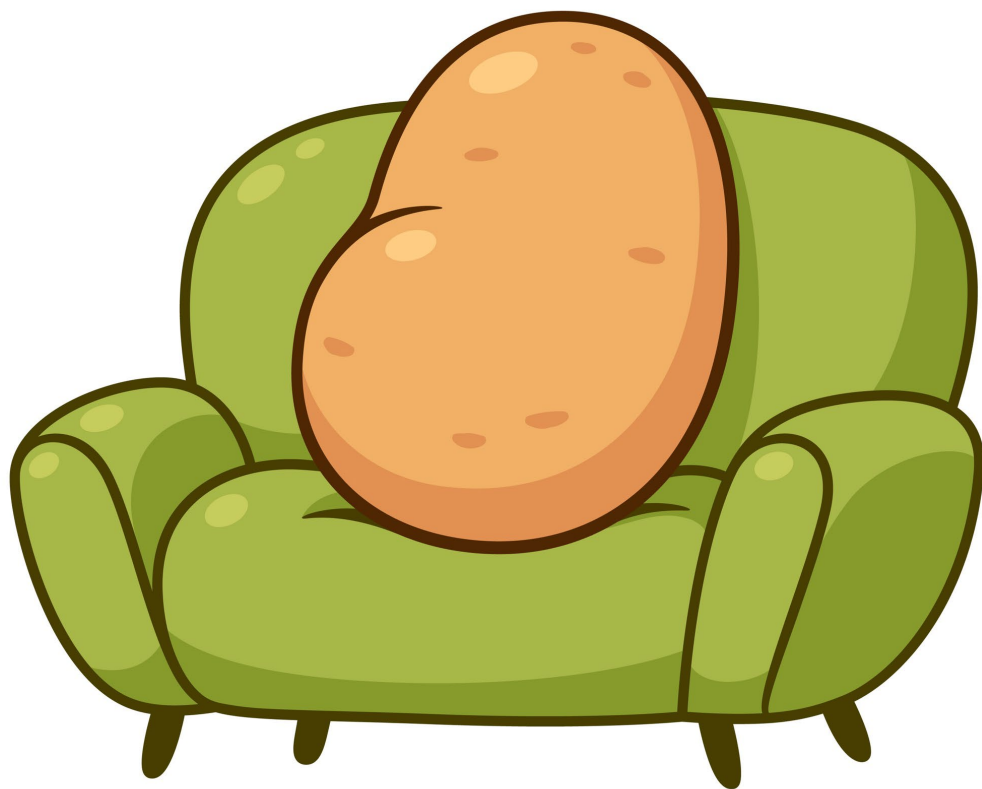


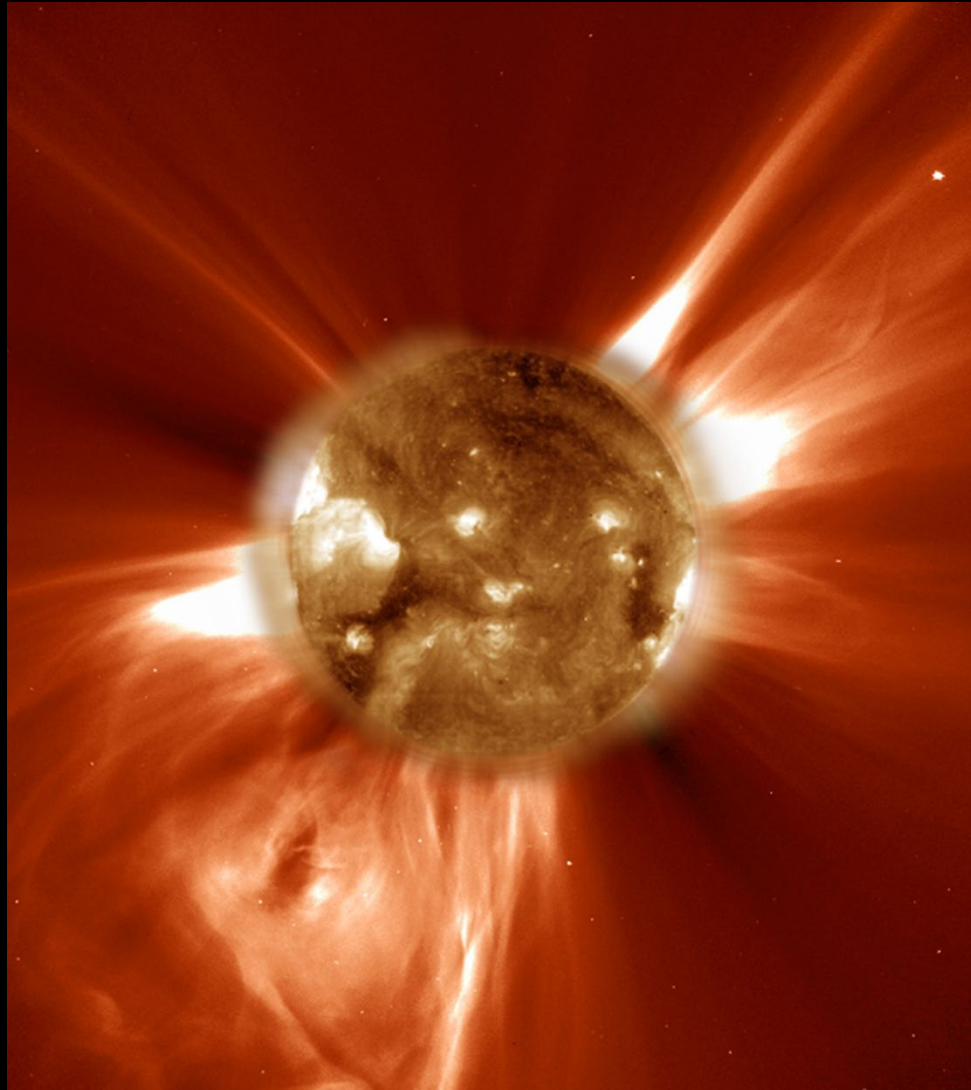




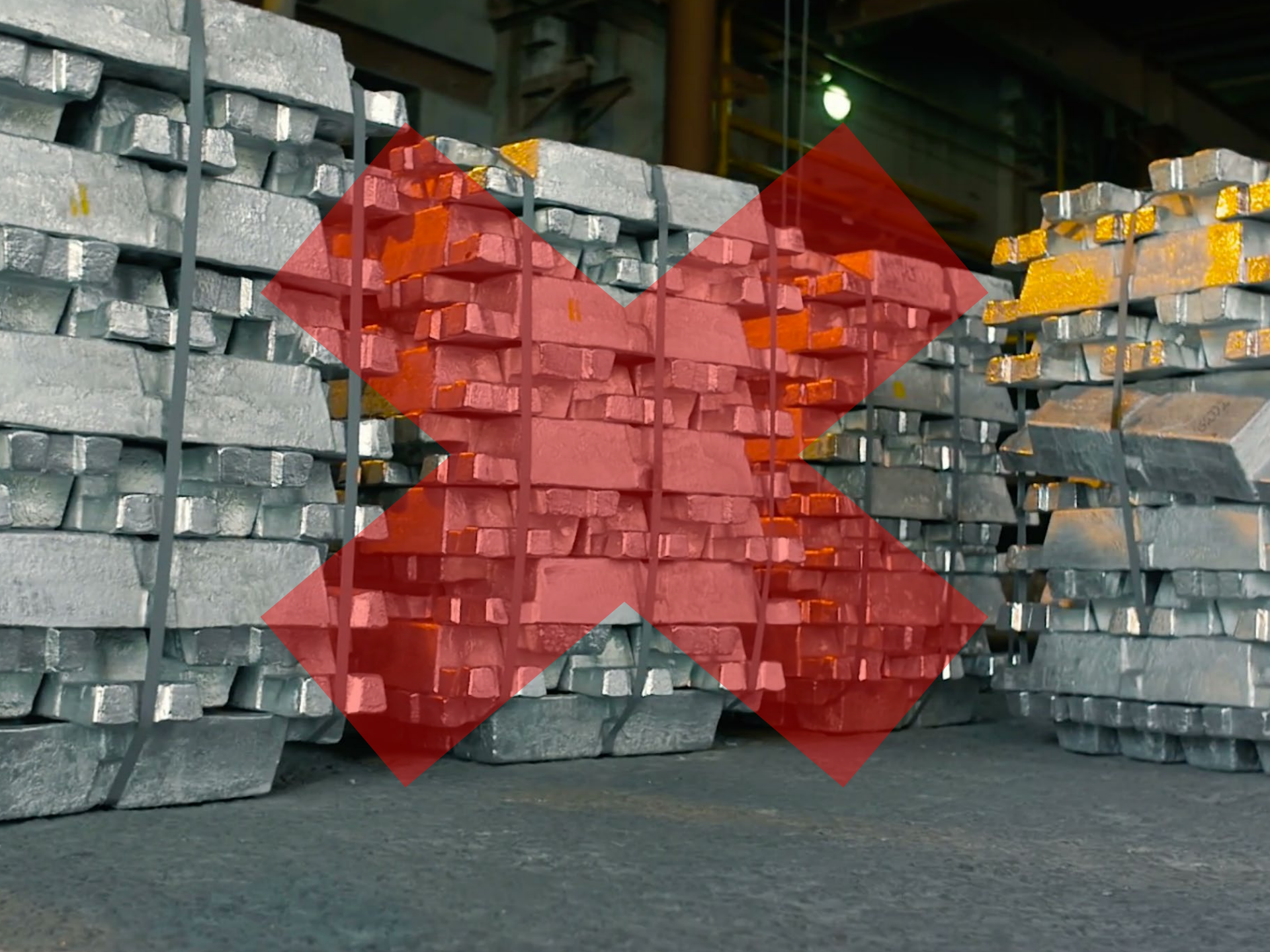
ANATOMY OF THE EAR



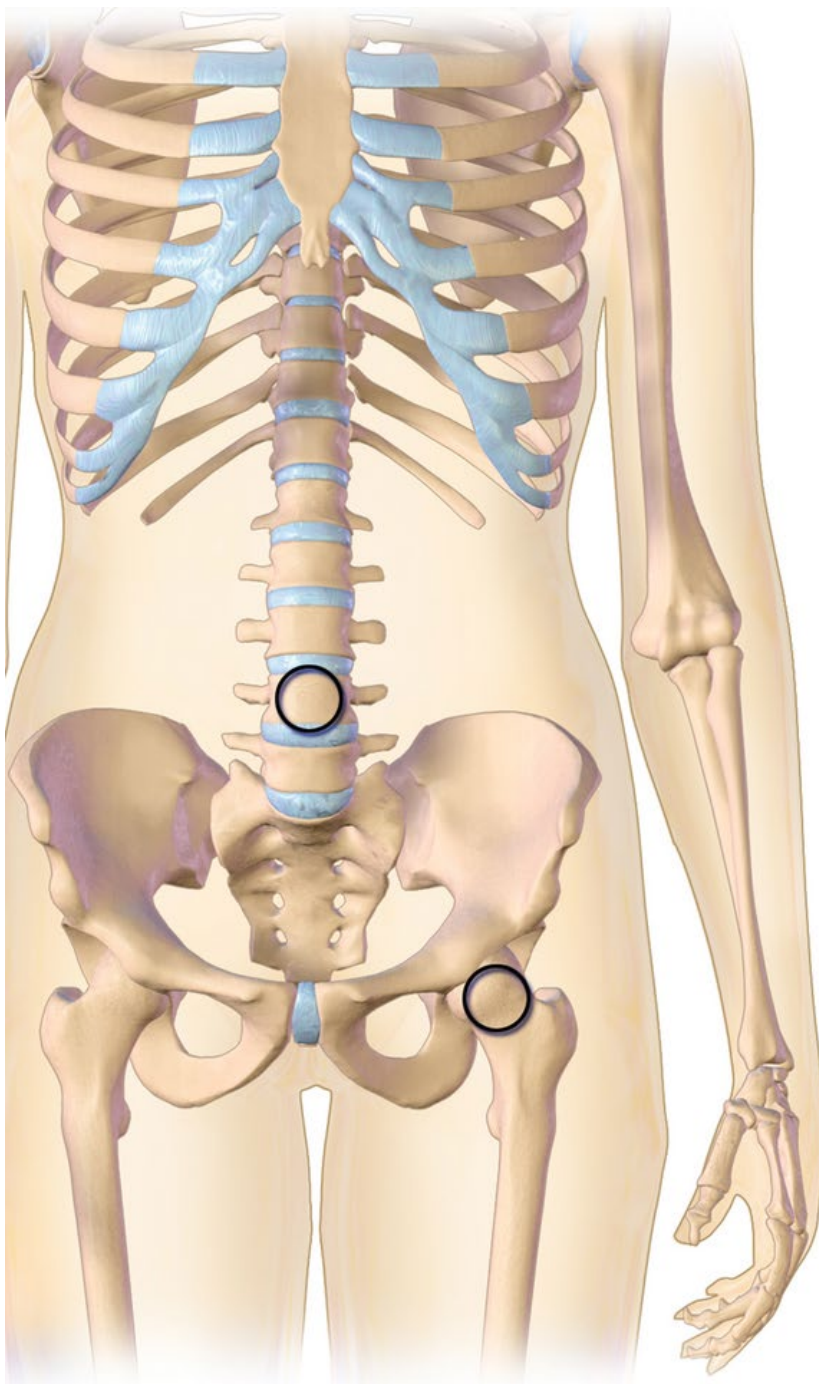












Normal bone

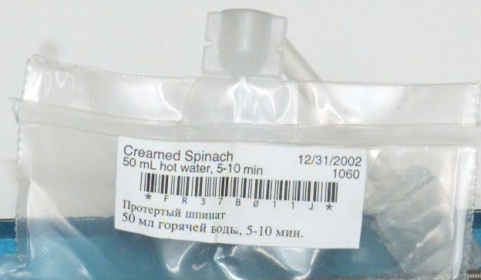
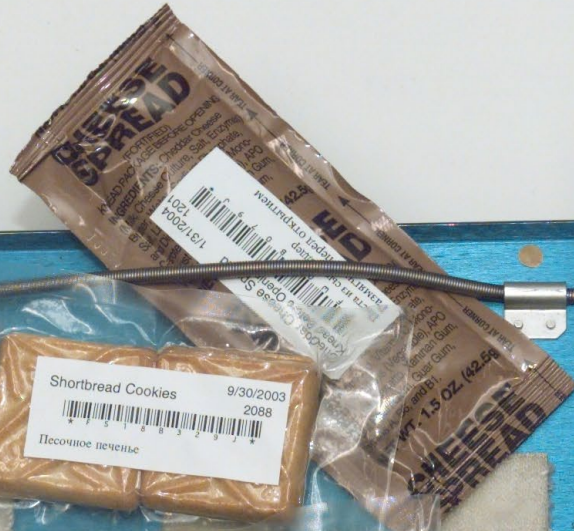


Osteoporosis

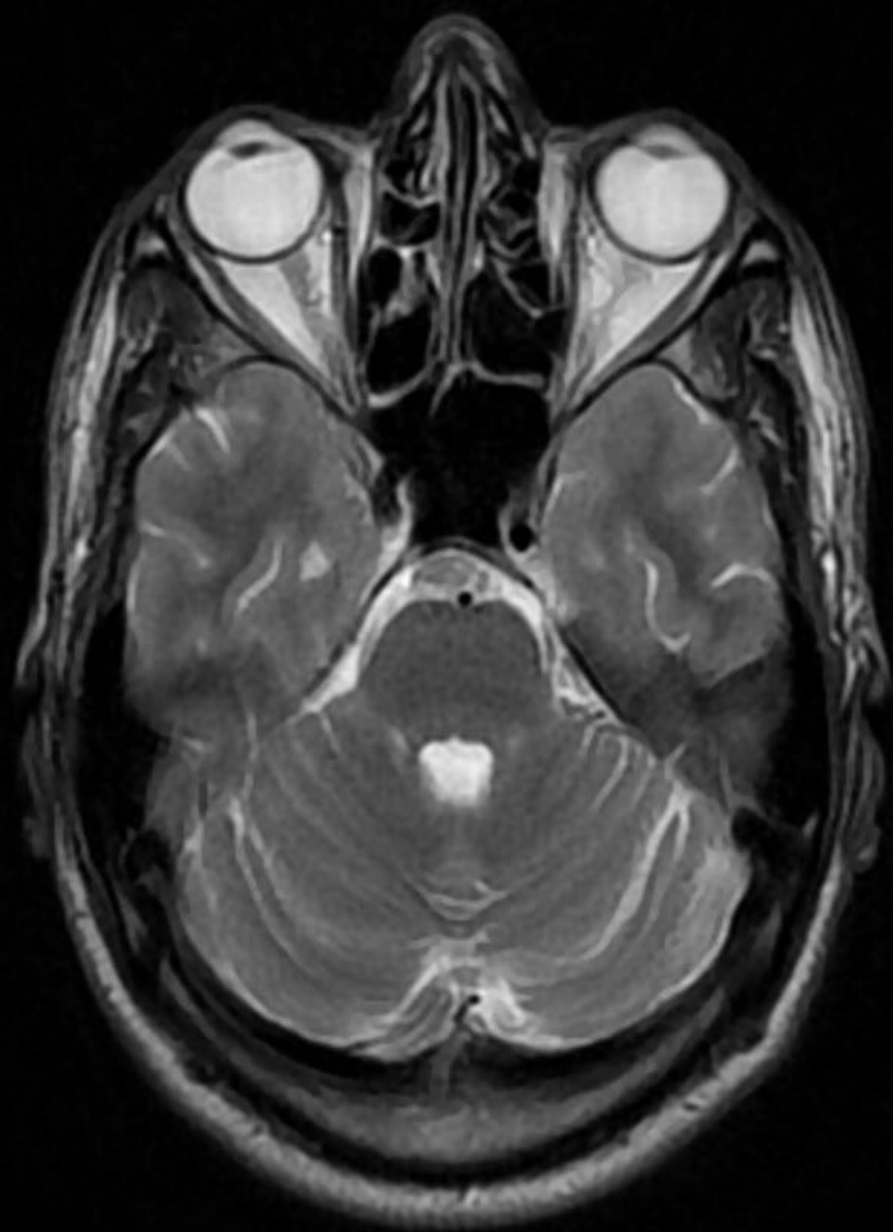






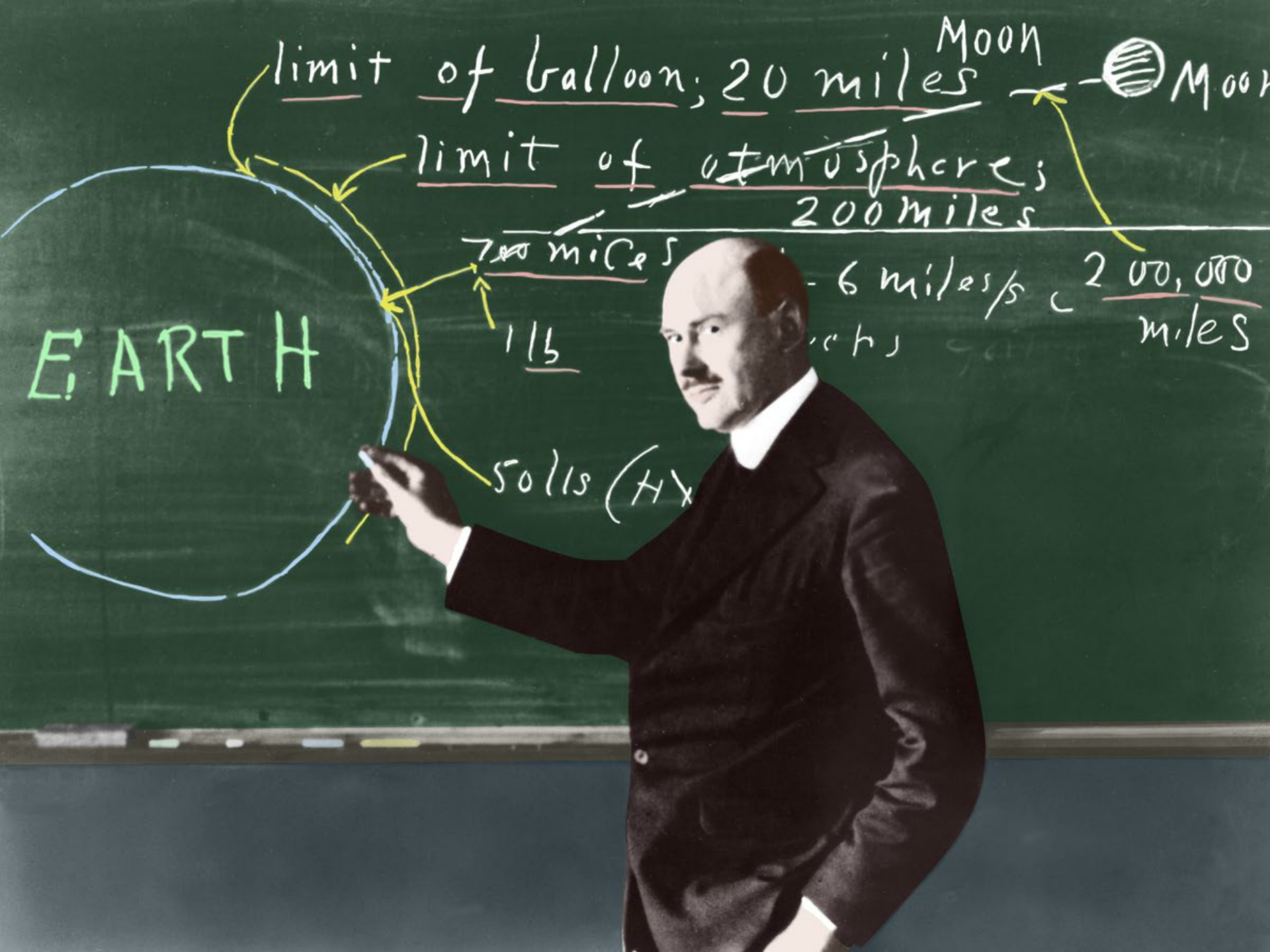












limit of balloon; 20 miles

Moon



Moon

limit of atmosphere;
200 miles

200 miles

6 miles/s

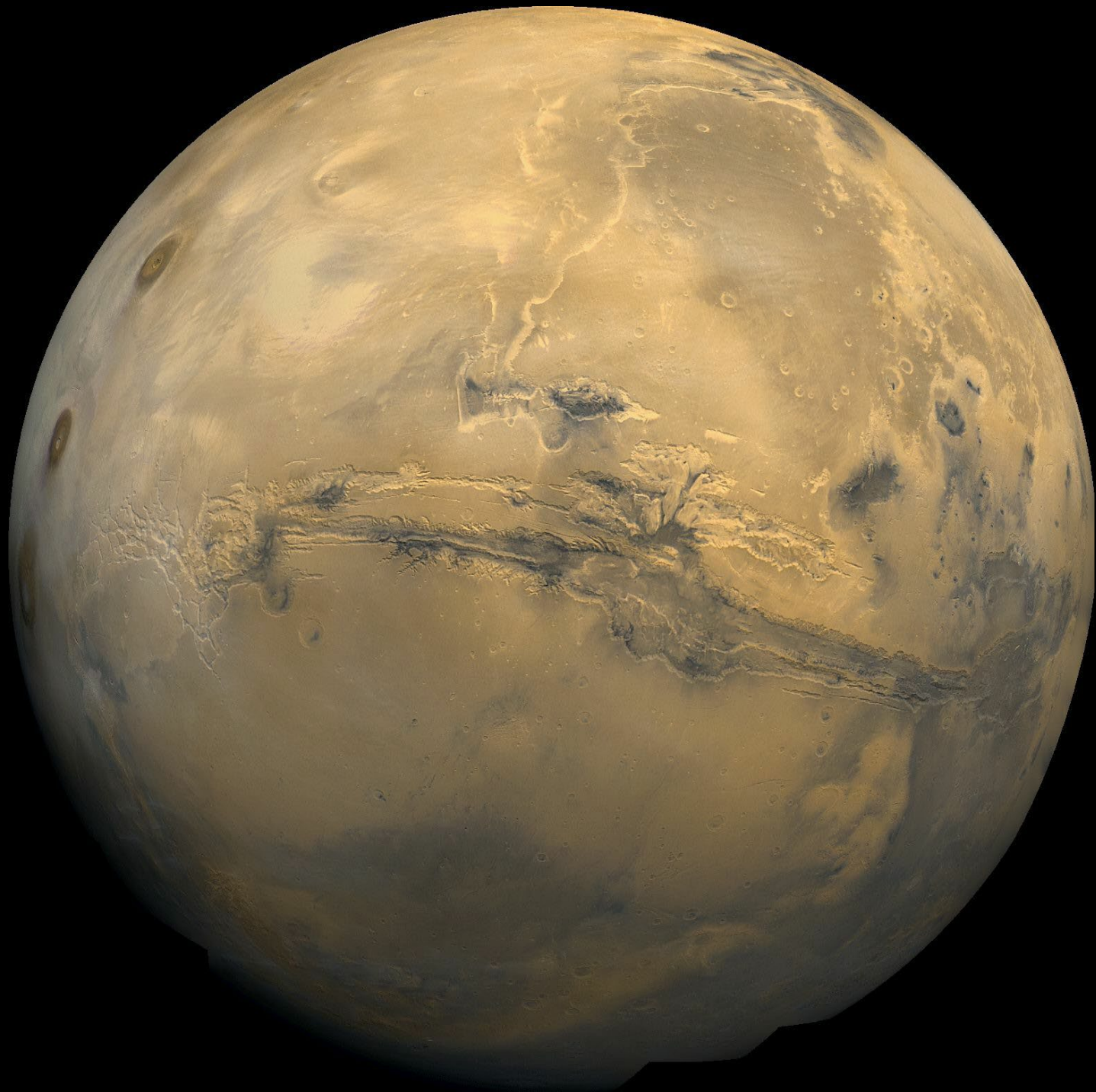
200,000
miles

115

50115 (Hx)

EARTH





The End

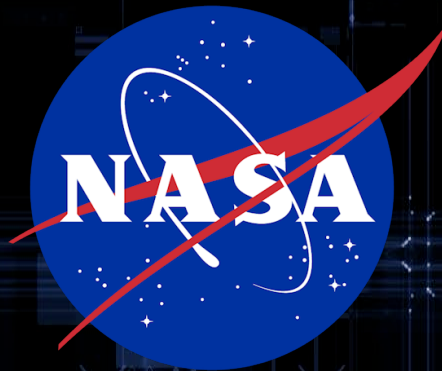


TALKS

WHERE NASA COMES TO TALK TECH

EARTH TO MARS IN 3 GIANT LEAPS

DR. STAN LOVE



TALKS

WHERE NASA COMES TO TALK TECH

WE'D LOVE YOUR
FEEDBACK!



FOR MORE NASA
TALK EPISODES

