HW 4

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Kirkwood Gaps

Your task is to *(1)* identify six Kirkwood gaps in this histogram, *(2)* calculate how long a hypothetical object inside the gap would take to orbit the Sun once, and *(3)* check that this object's orbit time is in resonance with Jupiter. *(4)* Lastly, write a Chicago-style reference for this web page.

First Gap

The first gap is at a distance of 2.05AU. Using the formula, I calculate an orbit time $= 2.05^{\frac{3}{2}} = 2.935$ years, in other words, a hypothetical asteroid at a distance of 2.5AU from the Sun would orbit the Sun once every 2.935 years. To check for resonance, I divide into Jupiter's orbit time of 11.86 years; $11.86 \text{ years}/2.935 \text{ years} =$ (years divided by years produces a unitless quantity). Or, I could write $11.86 : 2.935 = 4.04 : 1.00$. The simple ratio is therefore $4 : 1$. In other words, for every three asteroid orbits, Jupiter orbits exactly once. I have thus verified the $4 : 1$ orbit resonance.

Second Gap

The second gap is at a distance of 2.5AU. Using the formula, I calculate an orbit time $= 2.5^{\frac{3}{2}} = 3.95$ years, in other words, a hypothetical asteroid at a distance of 2.5AU from the Sun would orbit the Sun once every 3.95 years. To check for resonance, I divide into Jupiter's orbit time of 11.86 years; $11.86 \text{ years}/3.95 \text{ years} = 3.00$ (years divided by years produces a unitless quantity). Or, I could write $11.86 : 3.95 = 3.00 : 1.00$. The simple ratio is therefore $3 : 1$. In other words, for every three asteroid orbits, Jupiter orbits exactly once. I have thus verified the $3 : 1$ orbit resonance.

Third Gap

The third gap is at a distance of 2.82AU. Using the formula, I calculate an orbit time $= 2.82^{\frac{3}{2}} = 4.74$ years, in other words, a hypothetical asteroid at a distance of 2.82AU from

the Sun would orbit the Sun once every 4.74 years. To check for resonance, I divide into Jupiter's orbit time of 11.86 years; $11.86 \text{ years} / 4.74 \text{ years} = 2.502$ (years divided by years produces a unitless quantity). Or, I could write $11.86 : 4.69 = 5.00 : 1.998$. The simple ratio is therefore $5 : 2$. In other words, for every three asteroid orbits, Jupiter orbits exactly once. I have thus verified the $5 : 2$ orbit resonance.

Fourth Gap

The fourth gap is at a distance of 2.95AU. Using the formula, I calculate an orbit time $= 2.95^{\frac{3}{2}} = 5.07$ years, in other words, a hypothetical asteroid at a distance of 2.95AU from the Sun would orbit the Sun once every 5.07 years. To check for resonance, I divide into Jupiter's orbit time of 11.86 years; $11.86 \text{ years} / 5.07 \text{ years} = 2.339$ (years divided by years produces a unitless quantity). Or, I could write $11.86 : 5.07 = 7 : 2.99$. The simple ratio is therefore $7 : 3$. In other words, for every three asteroid orbits, Jupiter orbits exactly once. I have thus verified the $7 : 3$ orbit resonance.

Fifth Gap

The fifth gap is at a distance of 3.27AU. Using the formula, I calculate an orbit time $= 3.27^{\frac{3}{2}} = 5.91$ years, in other words, a hypothetical asteroid at a distance of 3.27AU from the Sun would orbit the Sun once every 5.91 years. To check for resonance, I divide into Jupiter's orbit time of 11.86 years; $11.86 \text{ years} / 5.91 \text{ years} = 2.006$ (years divided by years produces a unitless quantity). Or, I could write $11.86 : 5.07 = 2 : 0.997$. The simple ratio is therefore $2 : 1$. In other words, for every three asteroid orbits, Jupiter orbits exactly once. I have thus verified the $2 : 1$ orbit resonance.

Sixth Gap

The six gap is at a distance of 3.97AU. Using the formula, I calculate an orbit time $= 3.97^{\frac{3}{2}} = 7.91$ years, in other words, a hypothetical asteroid at a distance of 3.27AU from the Sun would orbit the Sun once every 7.91 years. To check for resonance, I divide into Jupiter's orbit time of 11.86 years; $11.86 \text{ years} / 7.91 \text{ years} = 1.499$ (years divided by years produces a unitless quantity). Or, I could write $11.86 : 7.91 = 3 : 2.001$. The simple ratio is therefore $3 : 2$. In other words, for every three asteroid orbits, Jupiter orbits exactly once. I have thus verified the $3 : 2$ orbit resonance.

Citation:

"Jupiter Facts." NASA, January 22, 2025. https://science.nasa.gov/jupiter/jupiter-facts/.

Gradie, J. C., Chapman, C. R., and Tedesco, E. F. 1989. "Distribution of Taxonomic Classes and the Compositional Structure of the Asteroid Belt." In Asteroids II, edited by R. P. Binzel, T. Gehrels, and M. S. Matthews, 321. Tucson: University of Arizona Press.