

Green's orbit

The Whorl list — 1 messages, 1 voices, 09 Apr 2000

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Adam Stephanides — 09 Apr 2000, 17:47

Apologies in advance to those bored by "techie stuff"; you can just skip this message.

Kieran Mullen wrote:

[I wrote:]

Furthermore, as someone else once pointed out, if Blue and Green's orbits brought them into conjunction as frequently as every six years, they would not be stable: the repeated perturbations from each other's gravity would pull them into new orbits.

Hmm... I don't think this is correct. It is true that if their periods were exactly integer multiples, you would have a problem (like the Shepherd Moons and the Cassini divisions of Saturn's rings). But if they are not integer multiples you should be ok, I think. (After all, the gaps in Saturn's rings do not deny the existence of the rings themselves!)

After reading your reply, I realized I didn't really know why "resonances" (to use the technical term) had the effects they did. So I did a little research, beginning with Newton's Clock: Chaos in the Solar System by Ivars Peterson, and going on to what non-technical articles dealing with the gaps in the asteroid belt (which seem to be better understood, and are a better analogy to our hypothetical situation) I could find in my local academic library. What I found out is that the situation is much more complex than I had realized.

In the first place, the picture I had in my head of repeated gravitational tugs gradually pulling the asteroid out of orbit is completely wrong. In the case of the 3/1 gap in the asteroid belt (where the period of the asteroid is a third that of Jupiter's), where the dynamics are the simplest and best understood, in numerical simulations an asteroid can spend up to a million years in a near-circular orbit and then jump to an eccentric orbit crossing Mars's. Moreover, to explain why there is a gap at the 2/1 resonance, you need to take into account the gravitational effects of Saturn as well. And at the 3/2 resonance, there is actually a cluster of asteroids, not a gap. So resonances with small numbers don't automatically imply unstable orbits.

On the other hand, there are no asteroids with periods equal or near to six-sevenths of Blue's (which Green's is most likely to be if it has an "ordinary" orbit). And a numerical simulation of 3000 randomly chosen orbits between the 2/1 gap and Jupiter's orbit yielded no surviving orbits in that region. On the other other hand, the fact that in OBW we have two bodies of comparable sizes, rather than an asteroid and Jupiter, may make a difference.

So I would sum up the findings of my research as follows:

1) The fact that Blue and Green reach conjunction every few years does not, in itself, imply that their orbits are unstable; but

2) The fact that Green's period would have to be close to six-seventh of Blue's probably means that its orbit would be unstable; but

3) I don't really know.

Does anybody know a good celestial mechanic? If not, I may make inquiries on sci.astro.

Finally, a minor point. If Blue and Green do have conjunctions every six years, it has to be exactly every six years, for reasons given in my reply to mantis below. But, as I said earlier, they may not.

mantis wrote:

Model 1: Two Planets (Earth and Venus), with standard Bode-Titus style orbits and a comparatively wide separation (significant fraction of an Astronomical Unit). (Problems: to see one as a looming disk from the surface of the other, the world has to be much closer than this suggests. Possible solution: ditch Bode-Titus! <g>)

Not just the appearance argues against Bode-Titus, but the tides: after all, Earth gets no tides from Venus. So Green has to be quite a bit closer. But ditching Bode-Titus shouldn't be a problem: it's just a numerical regularity with no known theoretical explanation, and it doesn't even work for Neptune (or Pluto either, but there are arguments that Pluto isn't really a planet).

At first I thought Kepler's Third Law would be a problem, but when you do the calculations, it isn't (at least I don't think so). Kepler's Third Law says that the ratio of the square of a planet's period to the cube of its semimajor axis (the average of its closest distance to the sun and its furthest distance away from the sun) is constant for the planets in a given system. Green seems to be hotter than Blue (the jungles), so its orbit is inside Blue's and its period is smaller. If its period is six-seventh of Blue's, then its semimajor axis is about .9 as long as Blue's. If the distance between Blue and Green at conjunction is insignificant compared to the distance between Blue and the Short Sun, and if we assume that blue's orbit is nearly circular, then Green's distance when closest to the Short Sun is about .8 its distance when furthest from the Short Sun, which doesn't seem too eccentric to allow life to evolve on Green (by comparison, Venus's average distance from the Sun is .72 times Earth's distance from the Sun). On the other hand, if Green's period is five-seventh that of Blue's, then under the same assumptions its closest approach to the Short Sun must be .6 times its furthest distance, which does seem excessive to me (though again, I'm not an expert).

So neither Bode-Titus nor Kepler argue against "ordinary" planetary orbits for Blue and Green. Stability may or may not, as I discuss above; and I still think that Horn's narrative implies that Green moves visibly across the sky, which is another problem for this model.

--Adam

*This is WHORL, for discussion of Gene Wolfe's Book of the Long Sun.