Example orbit for theoretical planet in the ν octantis system with 5:2 orbit ratio

S.Edgeworth

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The possible existence of a planet in the nu octantis system with 5:2 orbit ratio was proposed by Ramm et al [1], and investigated by other researchers [2] [3] [4] [5] [6].

This paper describes and illustrates a theoretical planetary orbit with 5:2 orbit ratio in a nu-octantis-like binary star system. First the full initial parameters used here for the orbits of the planet and two stars are listed:

[Primary star]
Mass = 1.4 SM
PosX = - 0.829286842105 AU
PosY = 0
VelX = 0
VelY = (0.178629233587 * 2 * pi) AU/EY

[Secondary star]
Mass = 0.5 SM
PosX = 2.32200315789 AU
PosY = 0
VelX = 0
VelY = (- 0.500161854036 * 2 * pi) AU/EY

[Planet]
Mass = 0.0038184 SM
PosX = 0.5388 AU
PosY = 0
VelX = 0
VelY = (1.1605 * 2 * pi) AU/EY

Abbreviations:
SM = the mass of our sun, AU = astronomical unit, EY = earth year, pi = 3.14159...

The orbits were integrated and optimised by orbit simulator software which I wrote in QT C++. A live integration of the orbits is available online [7], which uses an HTML5 version of the simulator. Additionally, a video presentation of the orbits is available [8].

Figure 1:

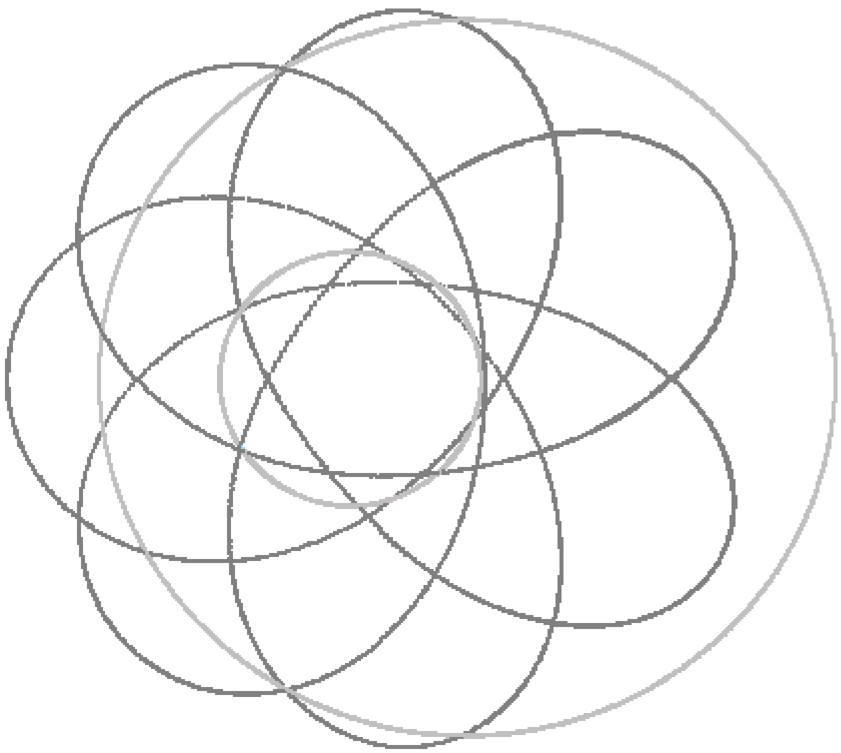

Figure 1 shows the barycentric view of the orbits. The stellar orbits are coloured light gray, and the planetary orbit is coloured dark gray. The planet follows a 7-lobed path, which is repeated once per 5 planetary orbits, and in that time the planet experiences 7 conjunctions and 7 oppositions.

The planetary orbit is a coplanar retrograde S-type orbit around the primary star, in a binary star system with stellar mass ratio and stellar orbital eccentricity approximating those of the nu octantis system.

Figure 2:

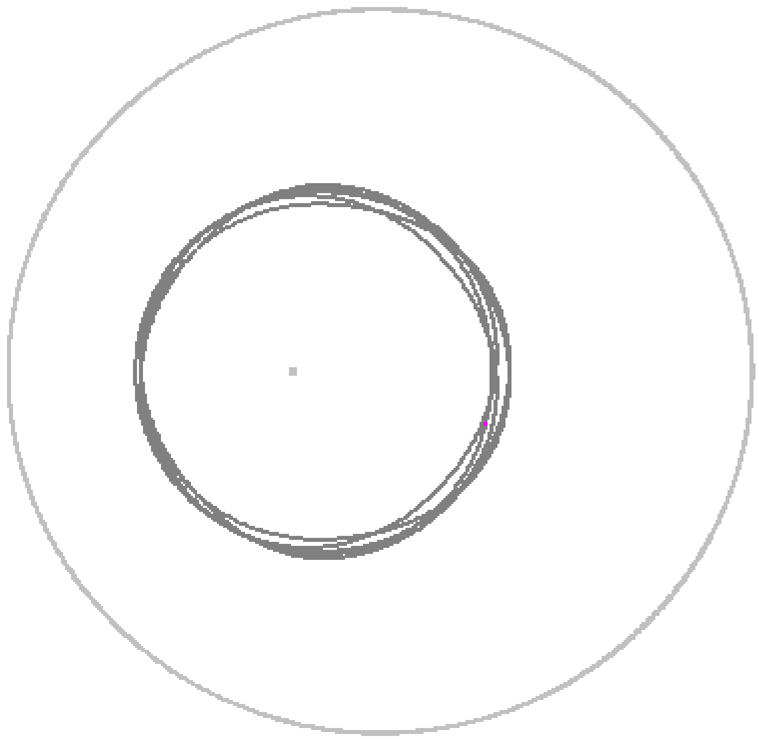

Figure 2 uses a non-barycentric viewing frame, which is centred always on the parent star. The parent star is therefore the light gray dot. The orbit of the secondary star is coloured light gray, and the planetary orbit is coloured dark gray. The planet follows a path which it repeats once per 5 planetary orbits. The planet's orbit in this view remains always within an orbital band. Remarkably, this orbital band is not centered on the parent star, but has a centre significantly offset from the parent star. This offset was previously described by [2].

Figure 3:

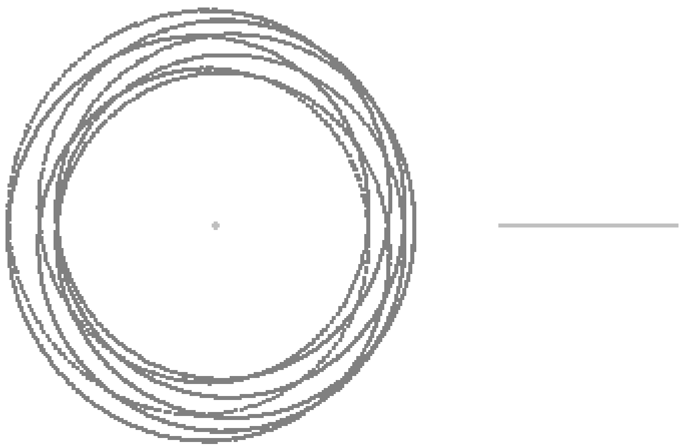

Figure 3 uses a co-rotating and non-barycentric viewing frame. The viewing frame is always centred on the parent star, and also the viewing frame rotates in synchronisation with the stellar orbits. The parent star is therefore the light gray dot. The orbit of the secondary star is coloured light gray (in this viewing frame it moves back and forth along a straight line) . The planetary orbit is coloured dark gray. The planet follows a defined path which it repeats once per 5 planetary orbital periods, and the various distances of the planet from its parent star, at each of the 7 conjuctions, can be seen.

The long-term behaviour of this planetary orbit is that is it is imperfectly resonant in 5:2 orbit ratio to the stellar orbital period, with the planet periodically gaining by a fraction of an orbit, relative to perfect resonance. The line of stellar apses precesses in the same direction as the motions of the two stars, at a rate estimated to be approximately 0.055 degrees per year. This is just one example of the range of exact planetary orbits attainable which are in approximately the 5:2 orbit ratio, and a better, fully resonant orbit may be possible.

References

[1] Spectroscopic orbits for K giants β Reticuli and ν Octantis: what is causing a low-amplitude radial velocity resonant perturbation in ν Oct?
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[2] On the reality of the suggested planet in the ν octantis system
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http://iopscience.iop.org/2041-8205/721/2/L168

[3] The Stability of the Suggested Planet in the nu Octantis System: A Numerical and Statistical Study
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[4] Precession due to a close binary system: An alternative explanation for ν-Octantis?
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[6] Dynamical analysis of the ν Octantis planetary system
Goździewski K., Słonina M., Rozenkiewicz A., Migaszewski C.
Proceedings of the workshop "Orbital Couples: Pas de Deux in the Solar System and the Milky Way". Held at the Observatoire de Paris, 10-12 October 2011. Editors: F. Arenou, D. Hestroffer. ISBN 2-910015-64-5, p. 97-102

[7] HTML5 orbit simulation: www.orbsi.uk/space/simulator/simulator.htm?s=00035

[8] Video presentation: vimeo.com/115945369

Version history:

v.1 02 Dec 2012

v.2 05 Jan 2015 added link to video.

v.4 05 Jan 2015 adjusted text to refer to improved video.

v.5 07 Jan 2015 updated URL of java simulation.

v.6 03 May 2015 updated video link, and added HTML orbit simulation link.

v.7 29 Nov 2017 removed java simulation, and improved formatting and wording.