Planetary Dynamics of the PSR 1257+12 System

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Paper by: Rasio, F. A., Nicholson, P. D., Shapiro, S. L., & Teukolsky, S. A. 1992

What are Millisecond Pulsars?

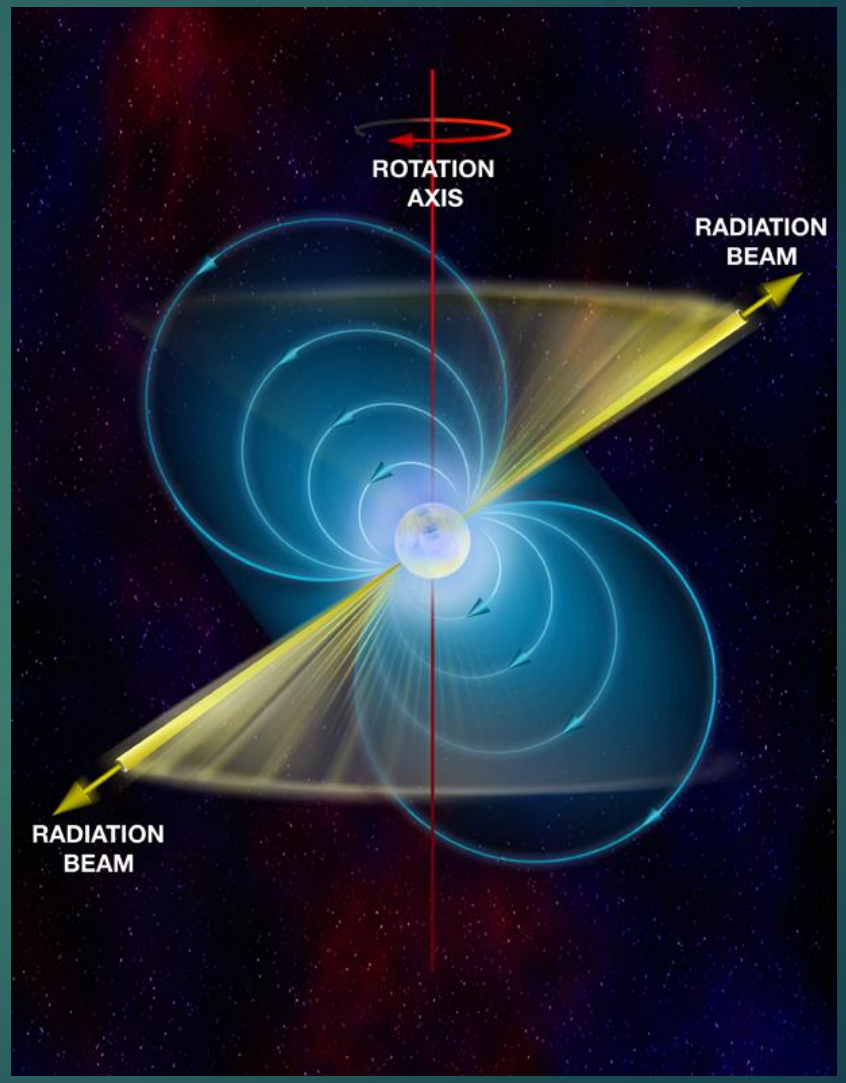
They are:

- in binaries.

- accreting material from their companion.

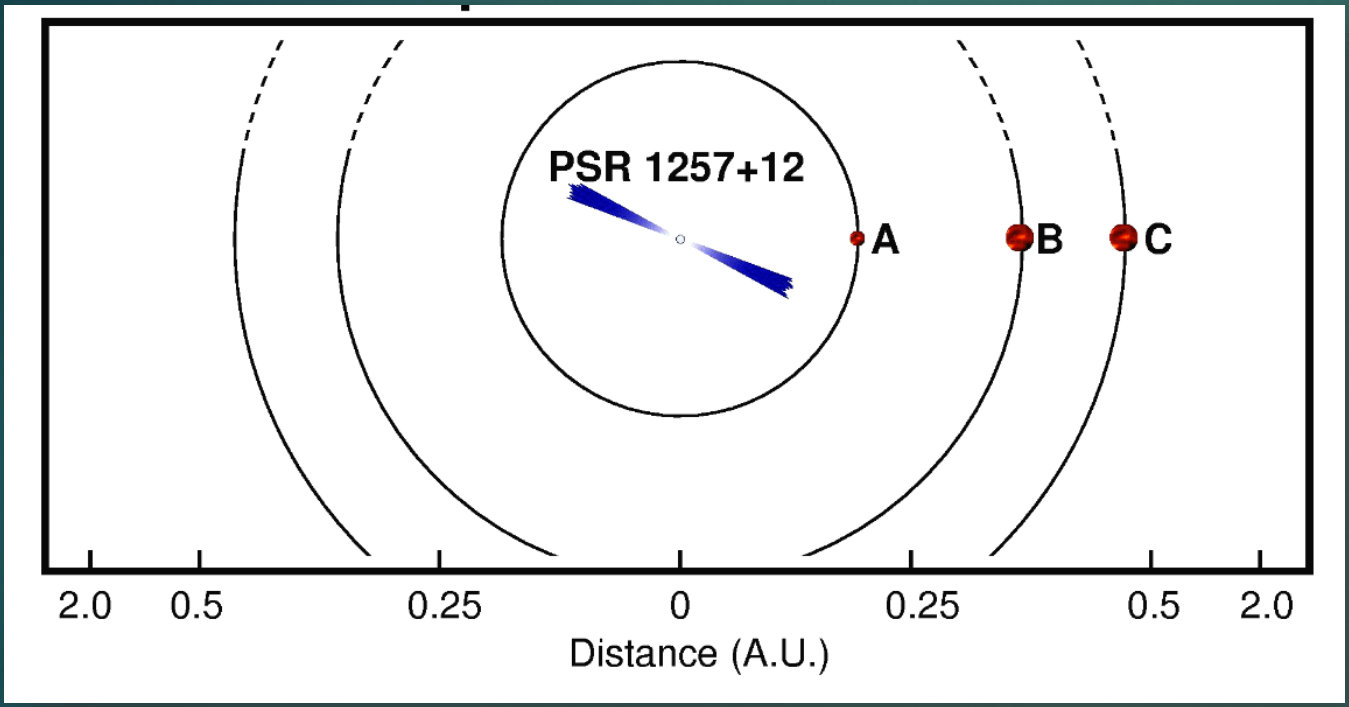
- vampires.

- very accurate clocks.



NRAO

What is the PSR 1257+12 System?



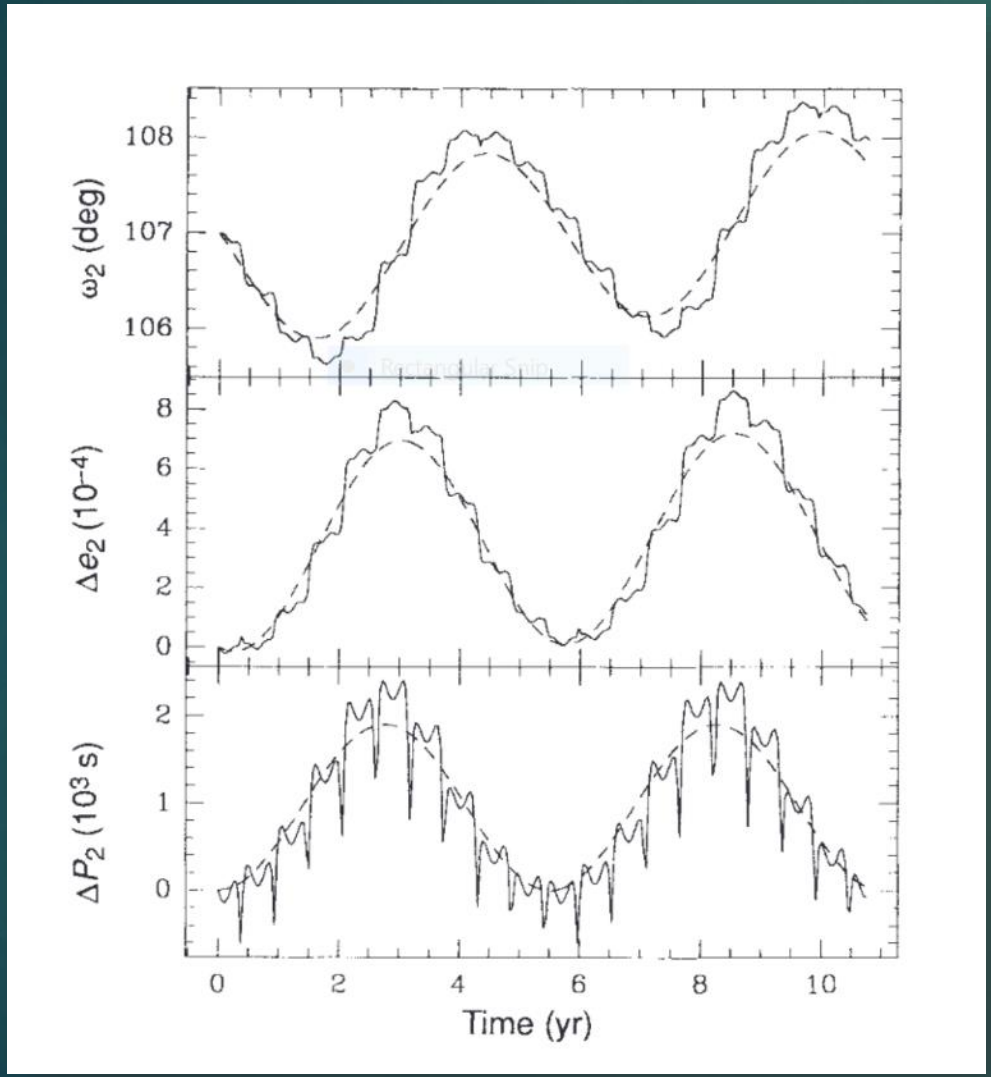
NRAO

The 6.2-ms pulsar displayed a periodic wobble

Two Earth-mass planets confirmed 1992

Planet A to be confirmed in 1994

What can we learn from this system?



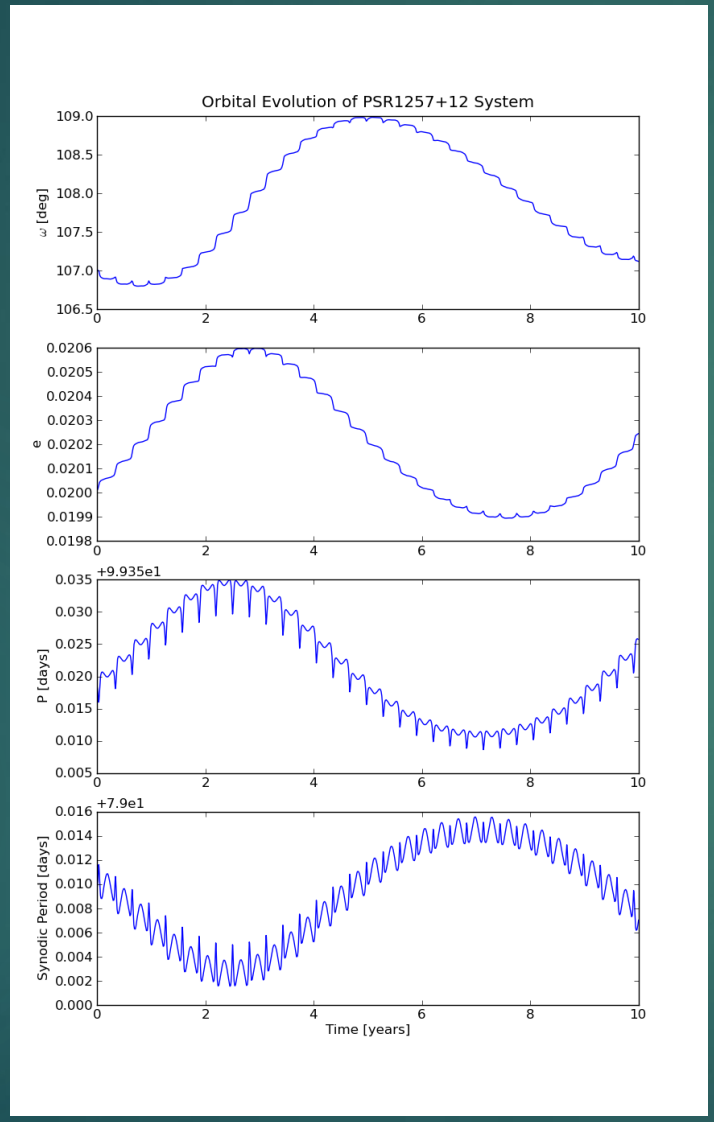
Rasio et al. calculated the evolution of the orbital parameters of the system

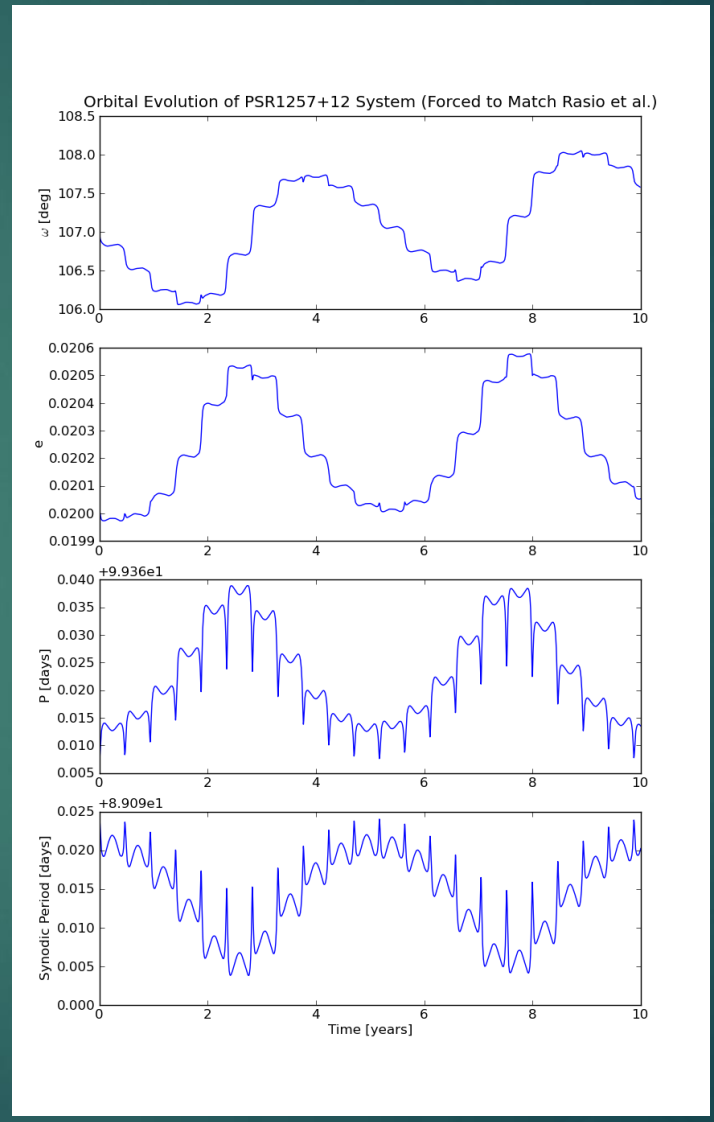
Small-scale features ➔ synodic period

Large-scale features ➔ 3:2 resonance of the periods

My Results:

I was unable to recreate their results using the values they provided.



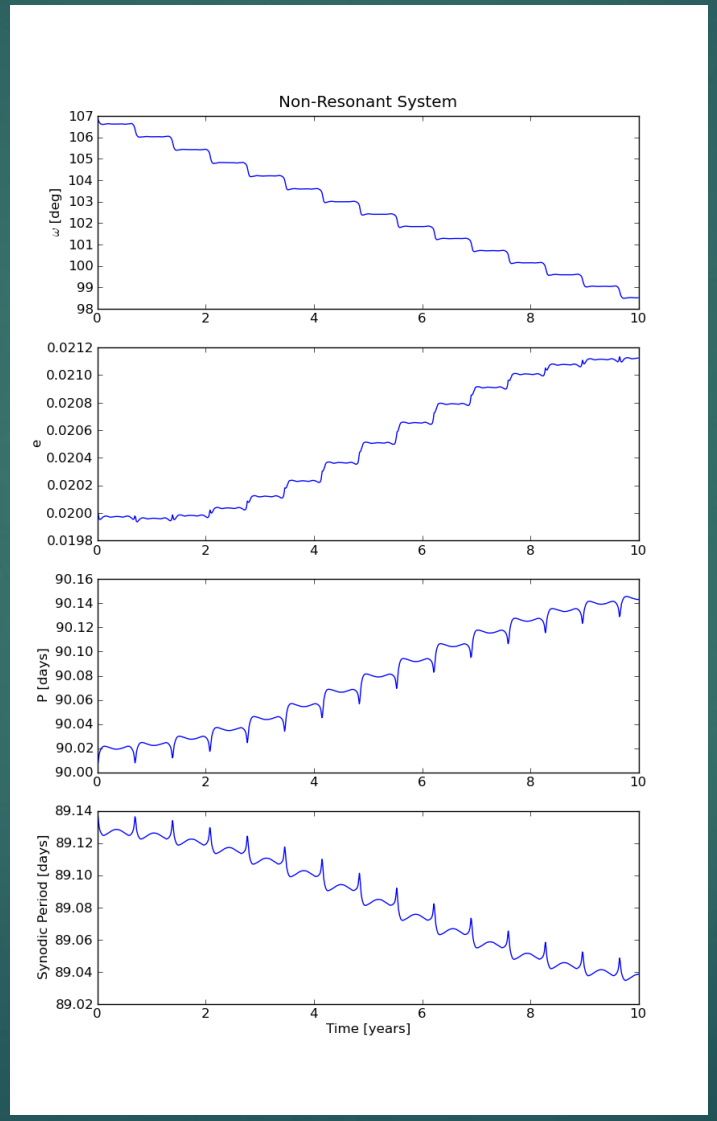


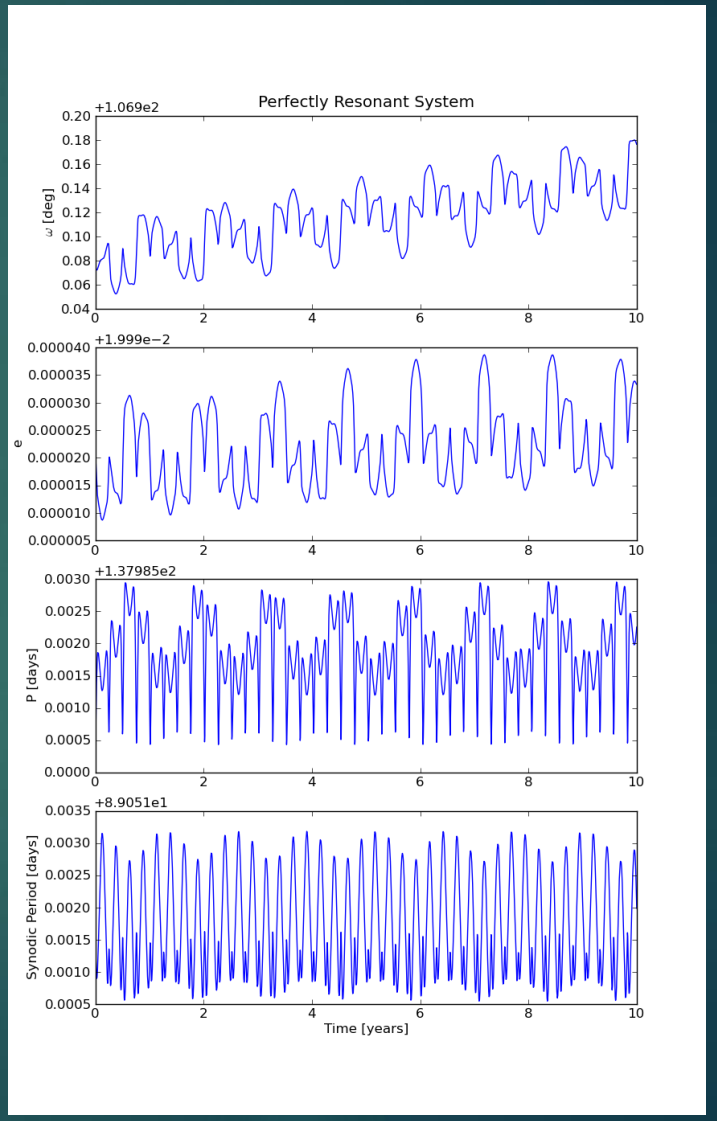
I changed the inputs until my results matched theirs.

What happens if we change the resonance?

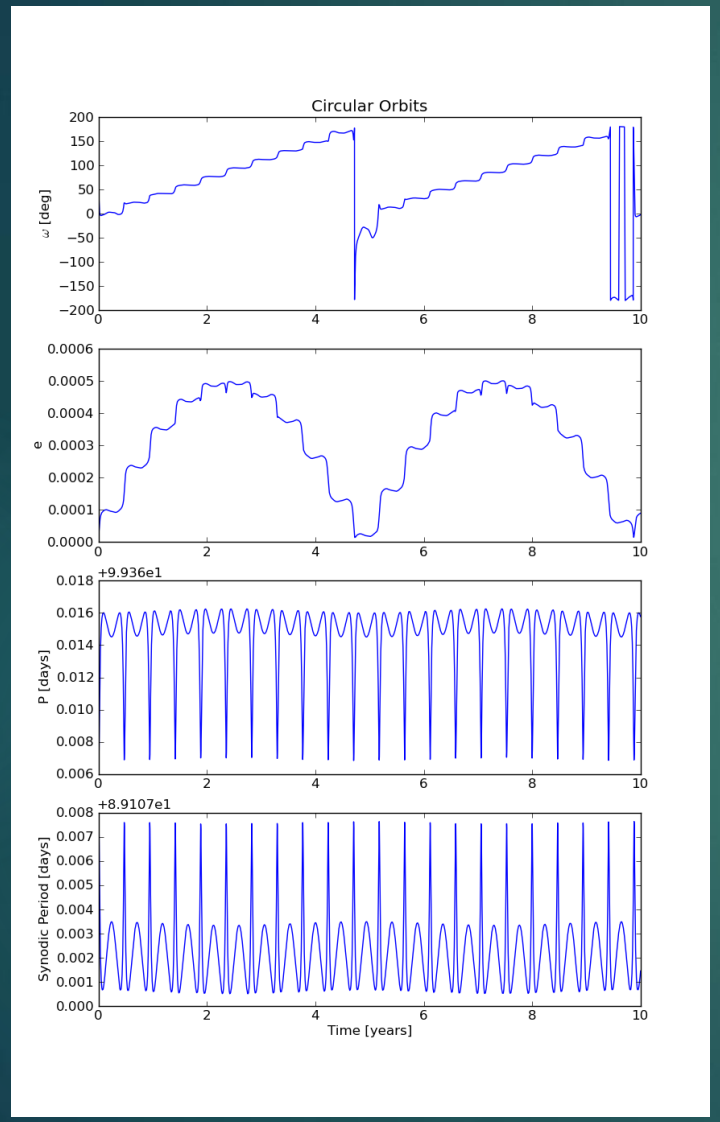
The near 3:2 resonance of the planets greatly amplifies the gravitational perturbations.

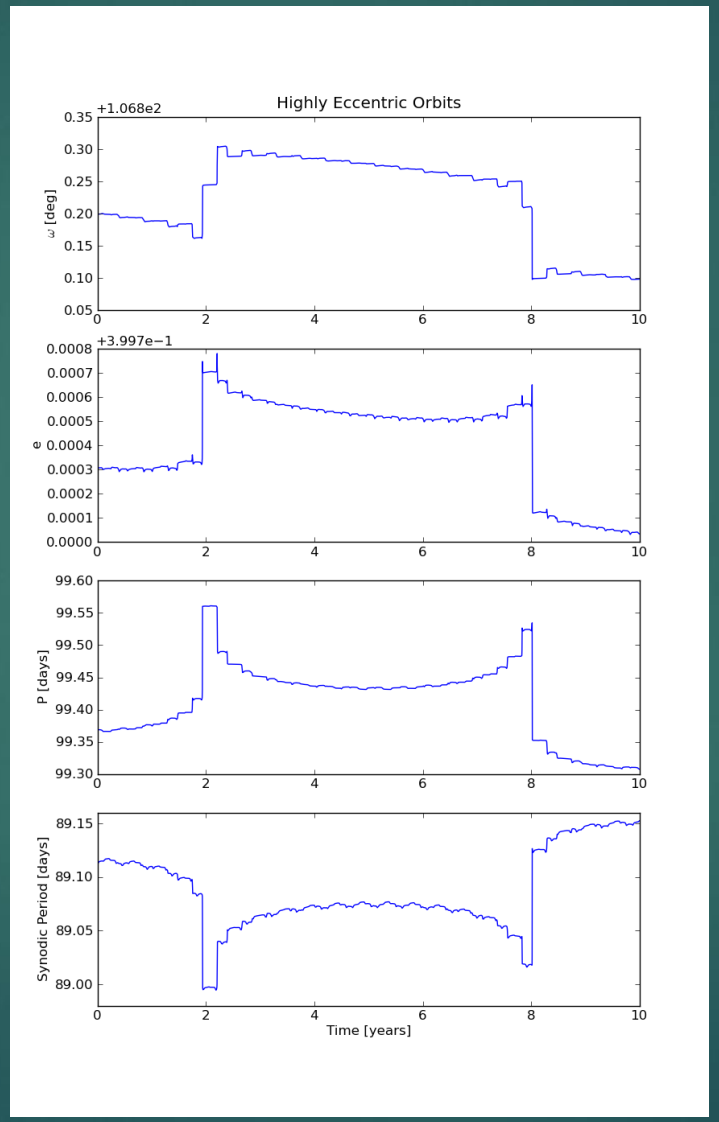
Without this they might have been undetectable.





What if we change the eccentricities?





The planets have low eccentricities (e~0.02).

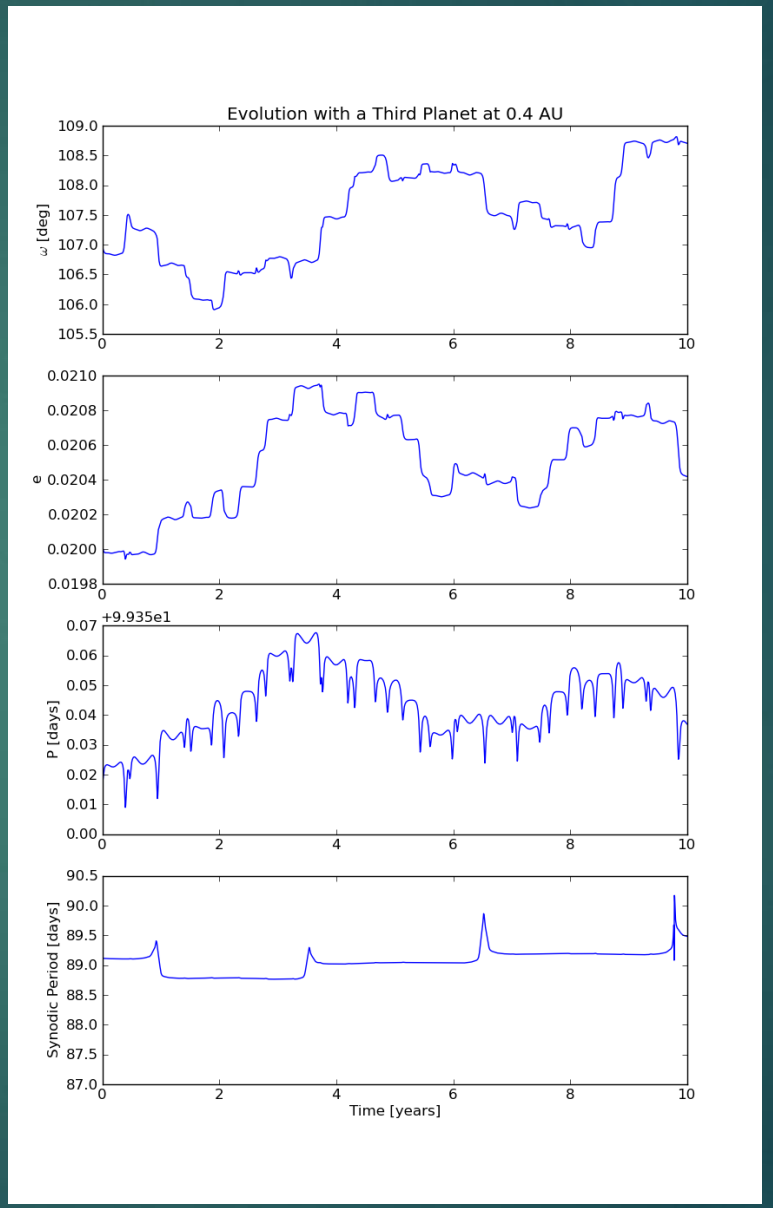
Perfectly circular orbits change over time but not on a large scale.

Eccentric orbits become more complicated.

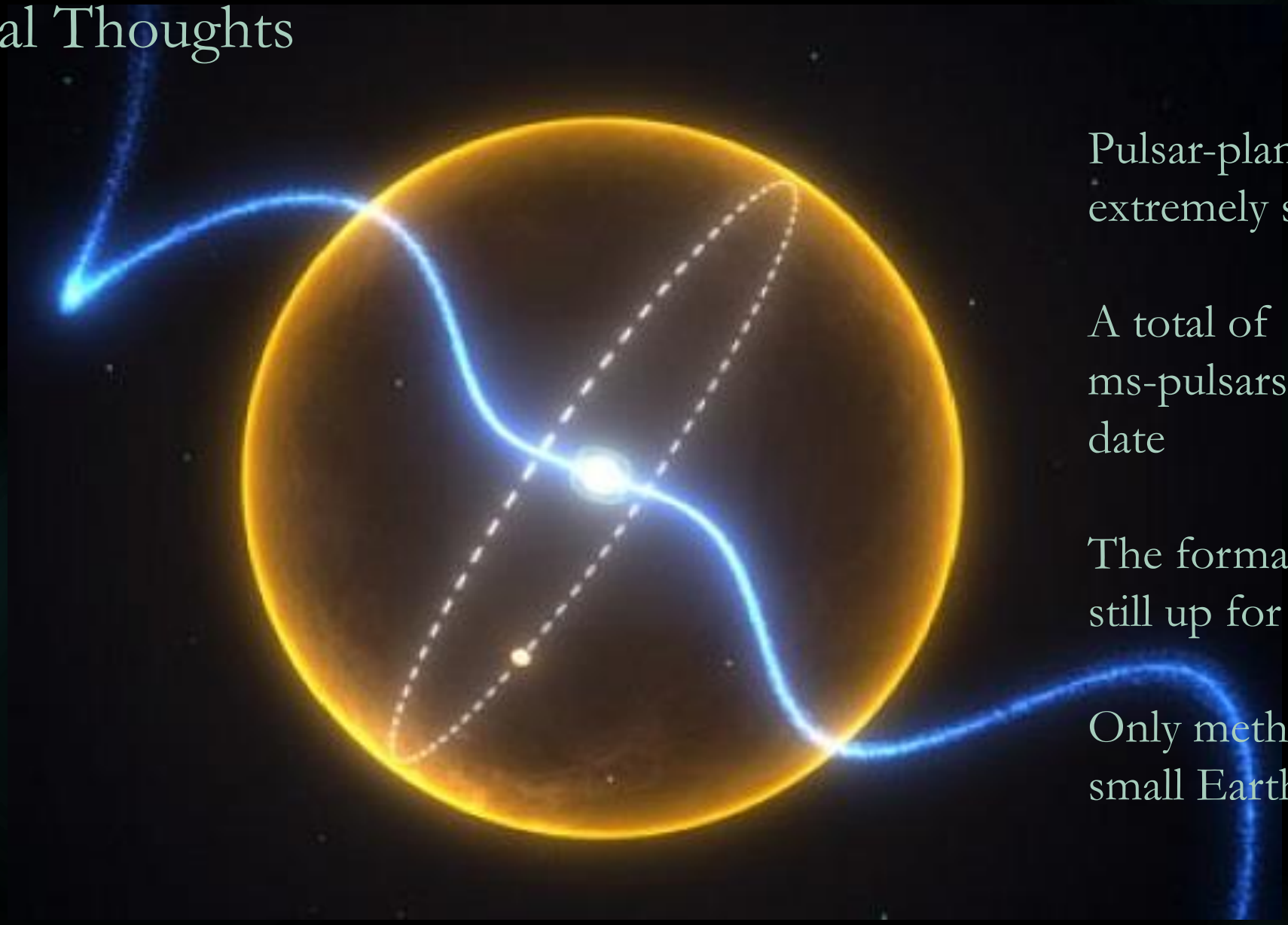
What if we add more planets to the system?

Adding a third, smaller planet has negligible effects on the evolution.

But adding a planet of comparable mass causes the system to behave more chaotically.



Final Thoughts



Pulsar-planet systems are extremely sensitive

A total of 5 planets from 3 ms-pulsars discovered to date

The formation theory is still up for debate

Only method to detect small Earth-sized planets