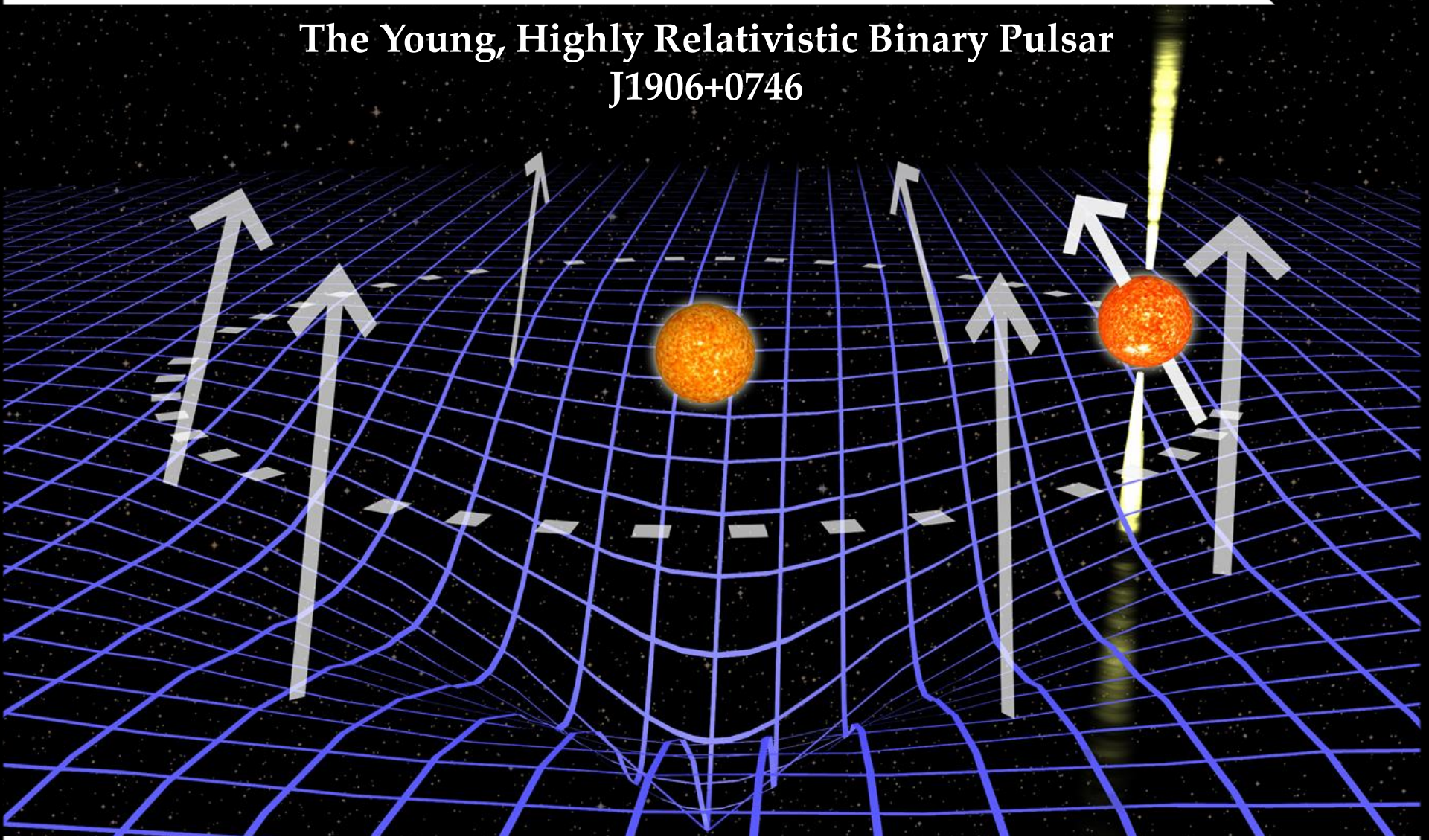
Universiteit van Amsterdam

Joeri van Leeuwen

ASTRON

The Young, Highly Relativistic Binary Pulsar J1906+0746

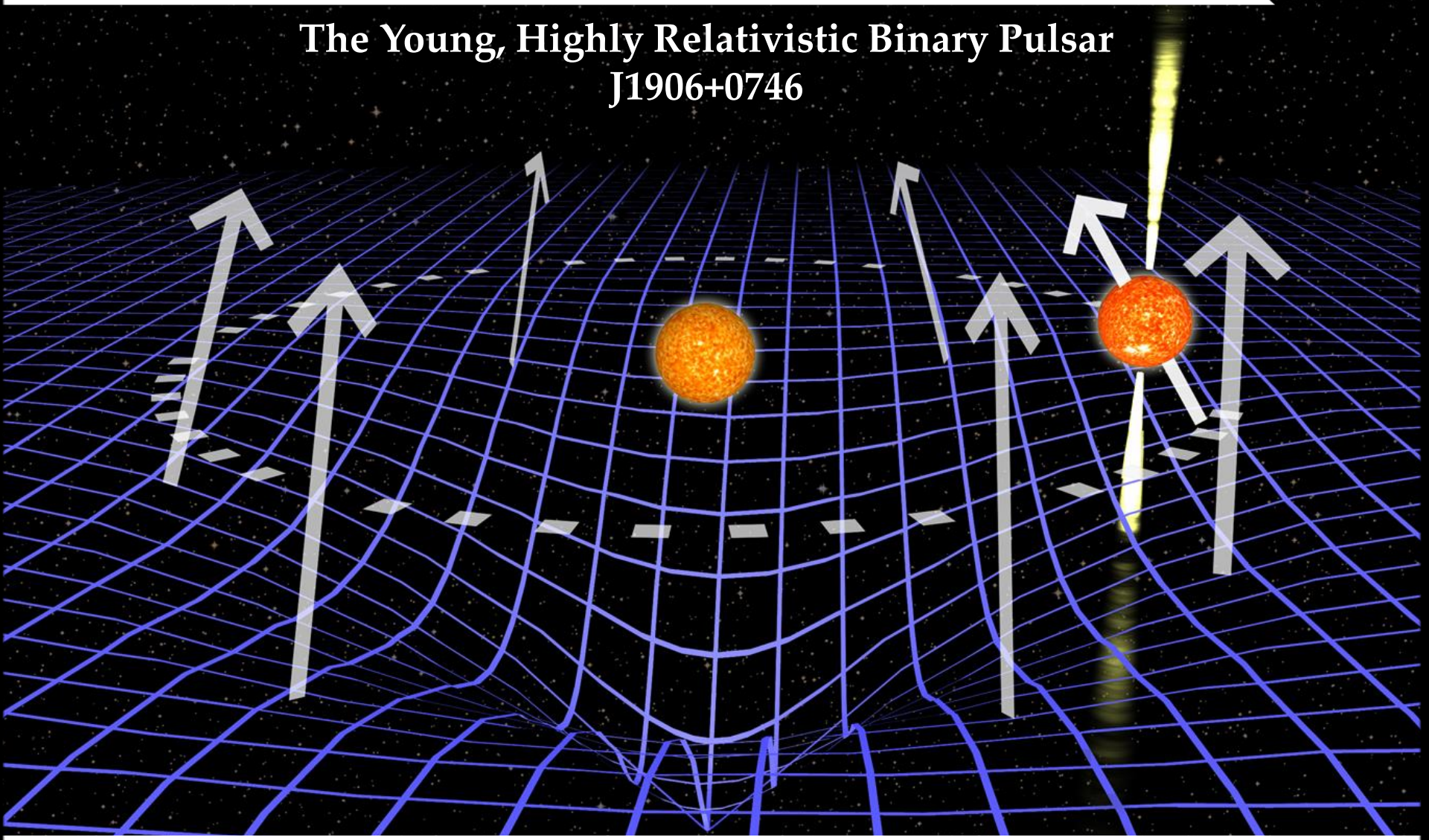


Universiteit van Amsterdam

Joeri van Leeuwen

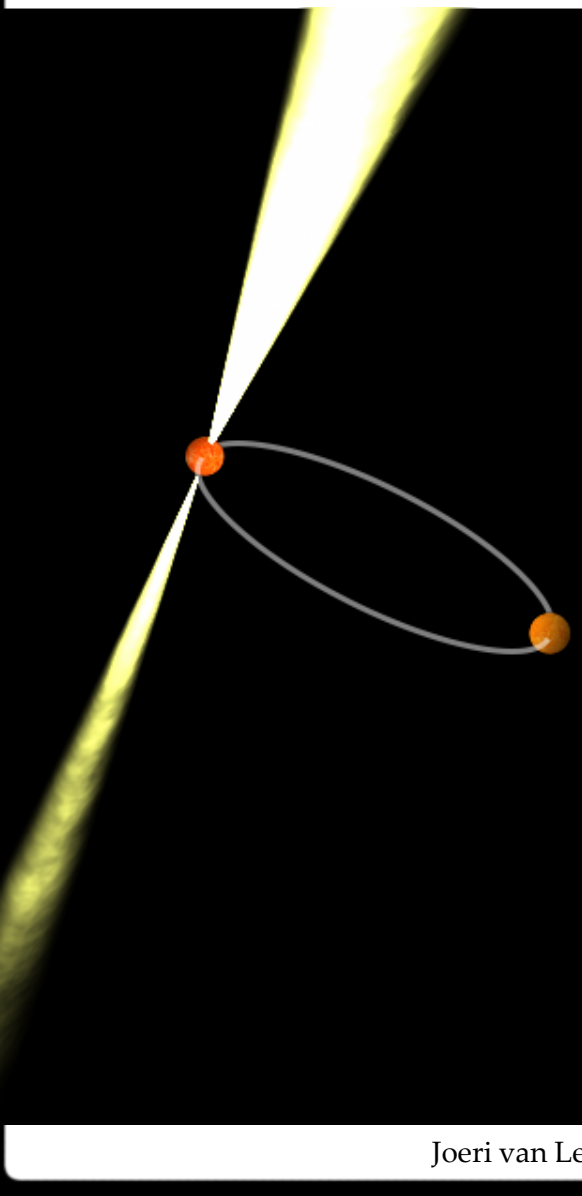
ASTRON

The Young, Highly Relativistic Binary Pulsar J1906+0746



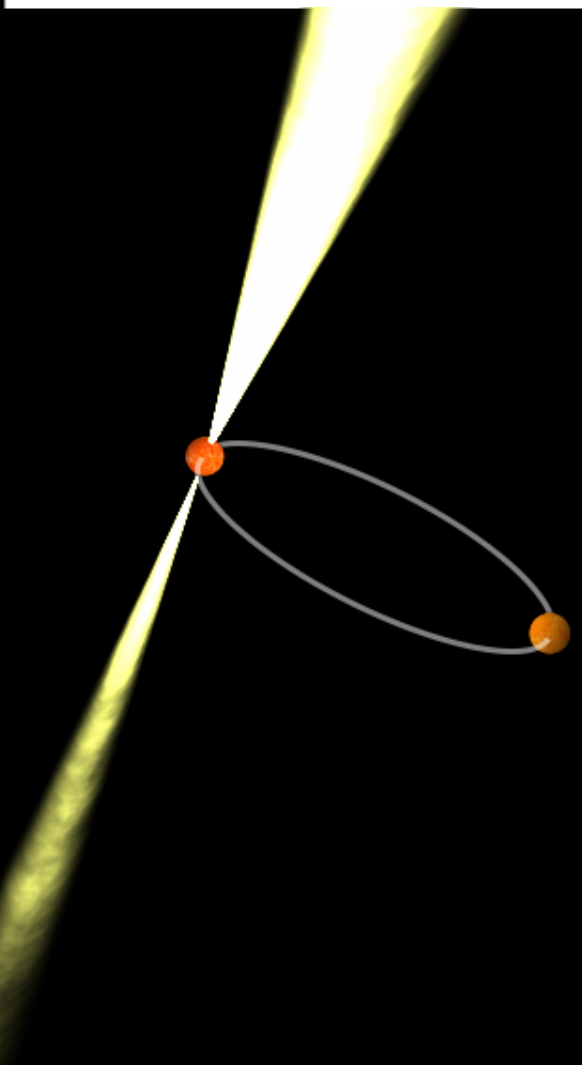
Gravity is intimately linked to the behavior of space and time on all scales in our Universe.

The Discovery of PSR J1906+0746



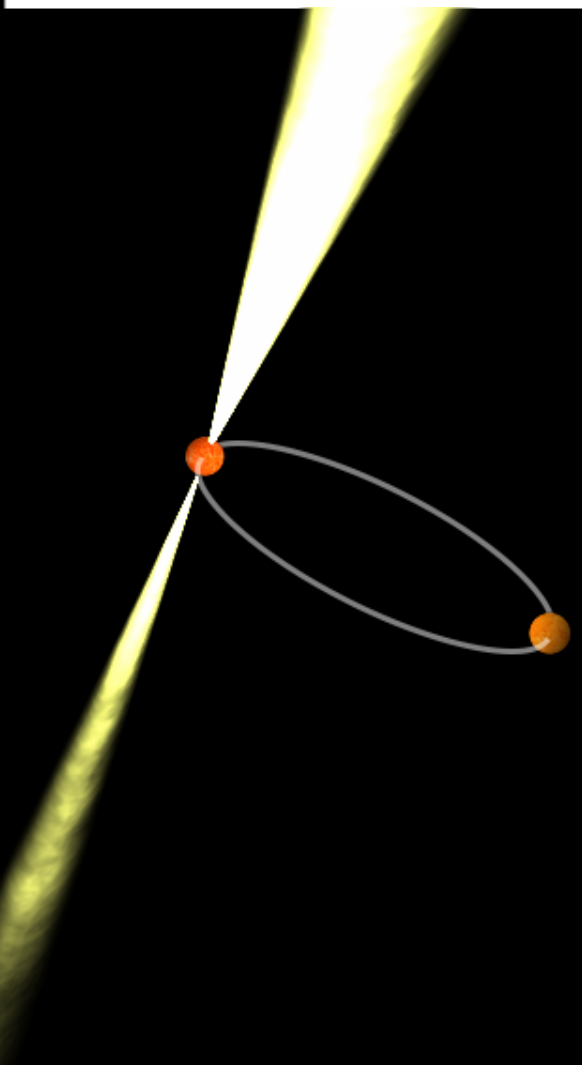
Very bright, fast pulsar suddenly found at Arecibo in 2004.

The Discovery of PSR J1906+0746



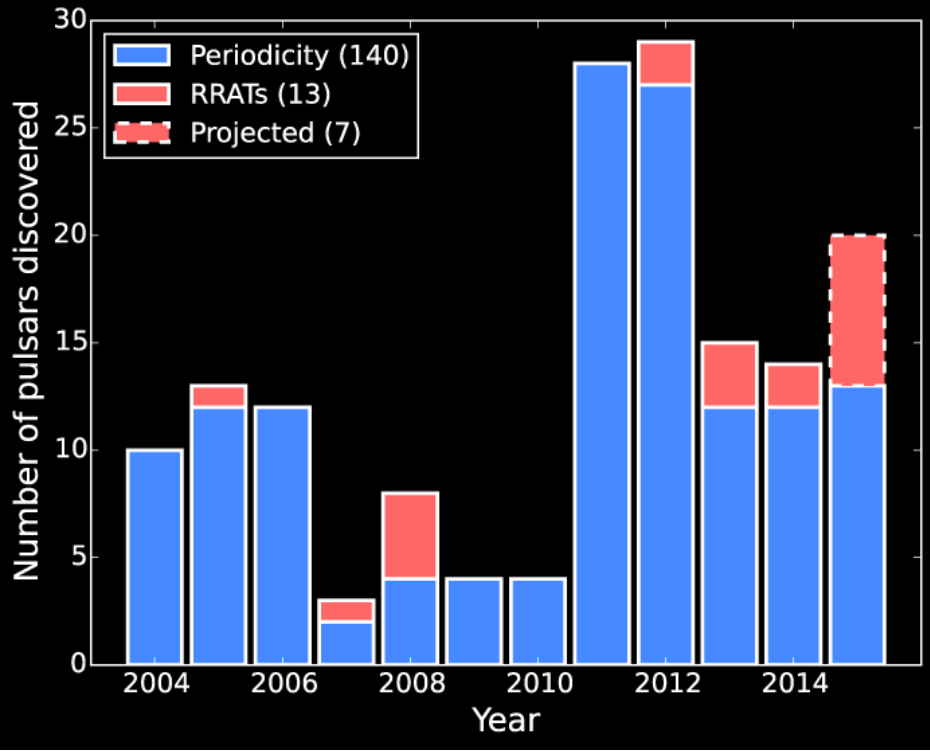
The Arecibo L-band Feed Array: 7-beam receiver operating at 1.4GHz.

The Discovery of PSR J1906+0746

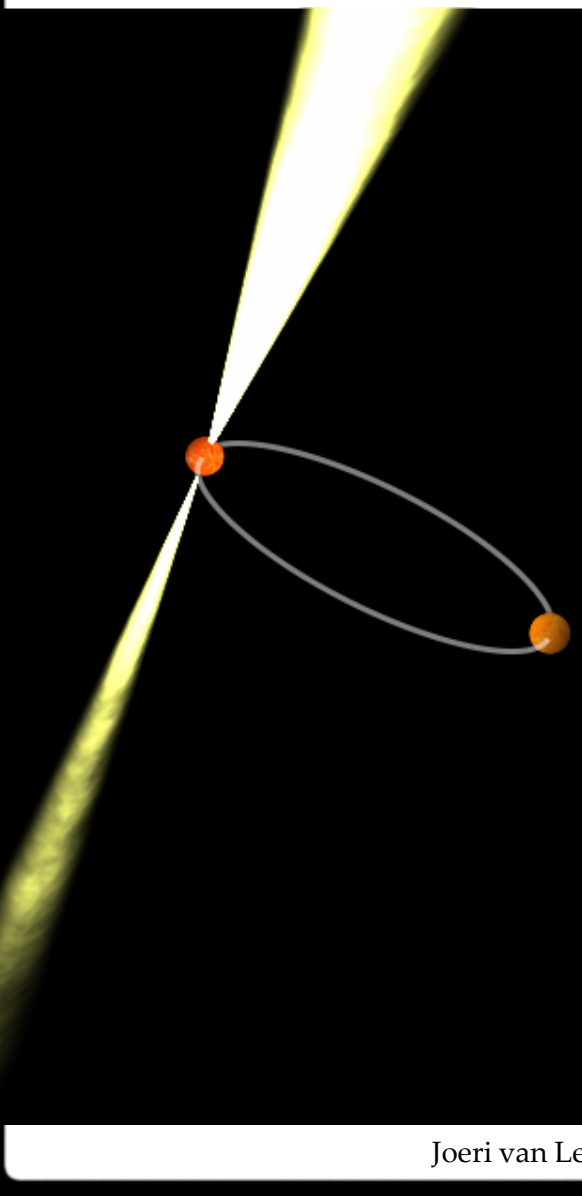


The Arecibo L-band Feed Array: 7-beam receiver operating at 1.4GHz.

PALFA discovered 163 new pulsars so-far.



The Discovery of PSR J1906+0746



Very bright, fast pulsar suddenly found at Arecibo in 2004.

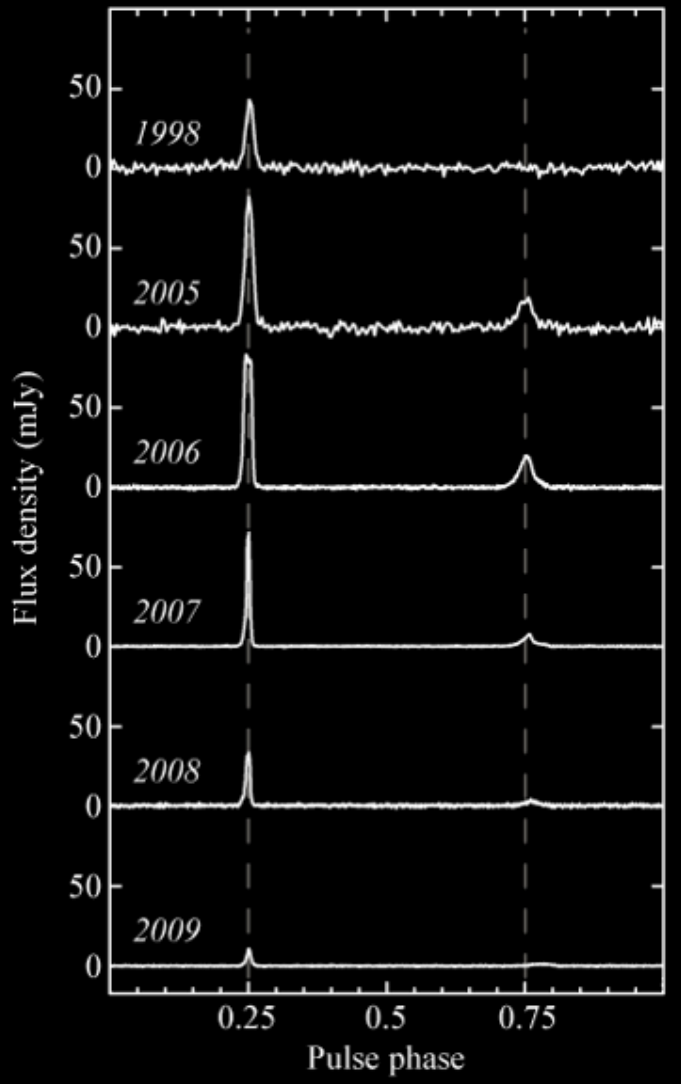
Spins every 144 milliseconds, orbits its companion every 3h59m: second-most relativistic system known.

Very young: 100,000 yrs. Practically unchanged since supernova.

The Discovery of PSR J1906+0746

Found in 2-min integration

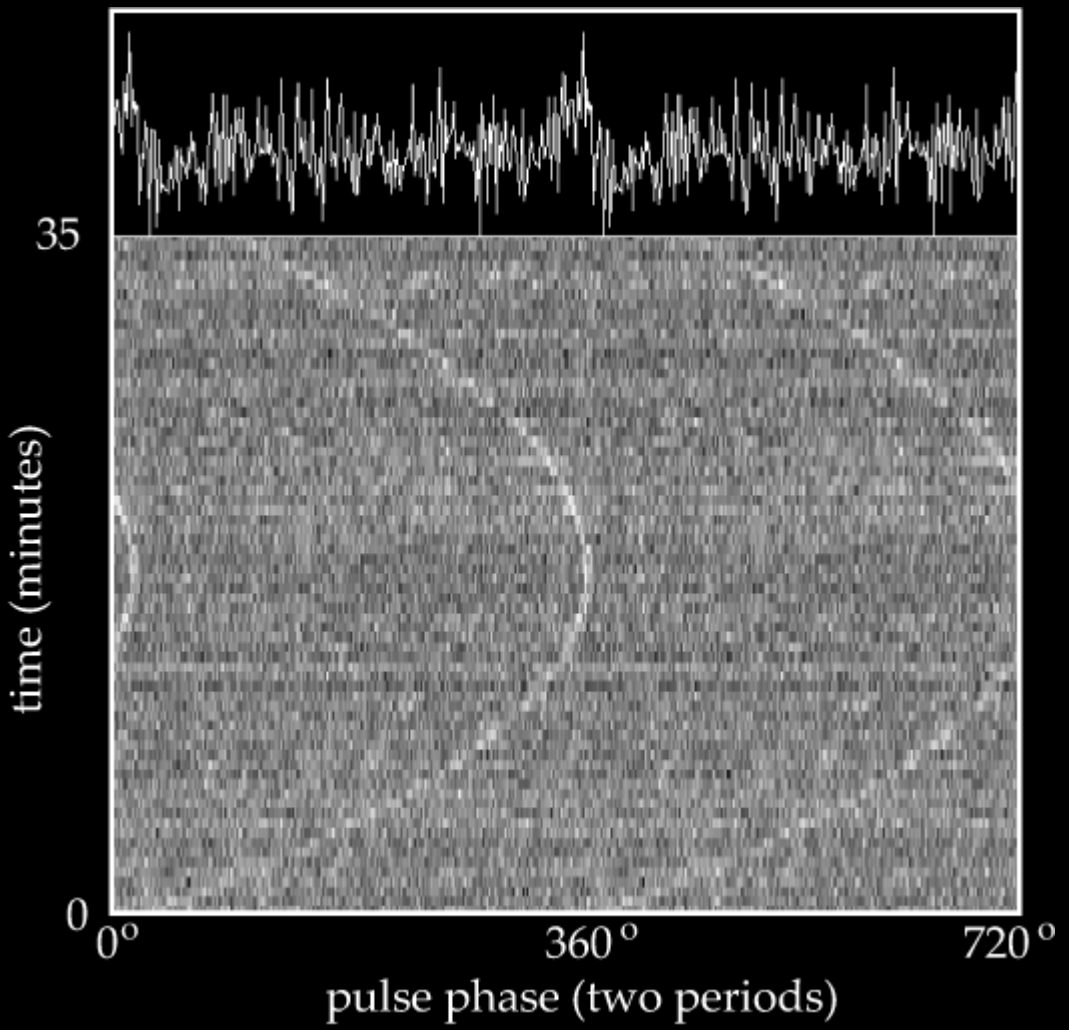
In a region of sky covered by Parkes Survey



van Leeuwen et al. 2015, ApJ 798, 118

The Discovery of PSR J1906+0746

Parkes detection:

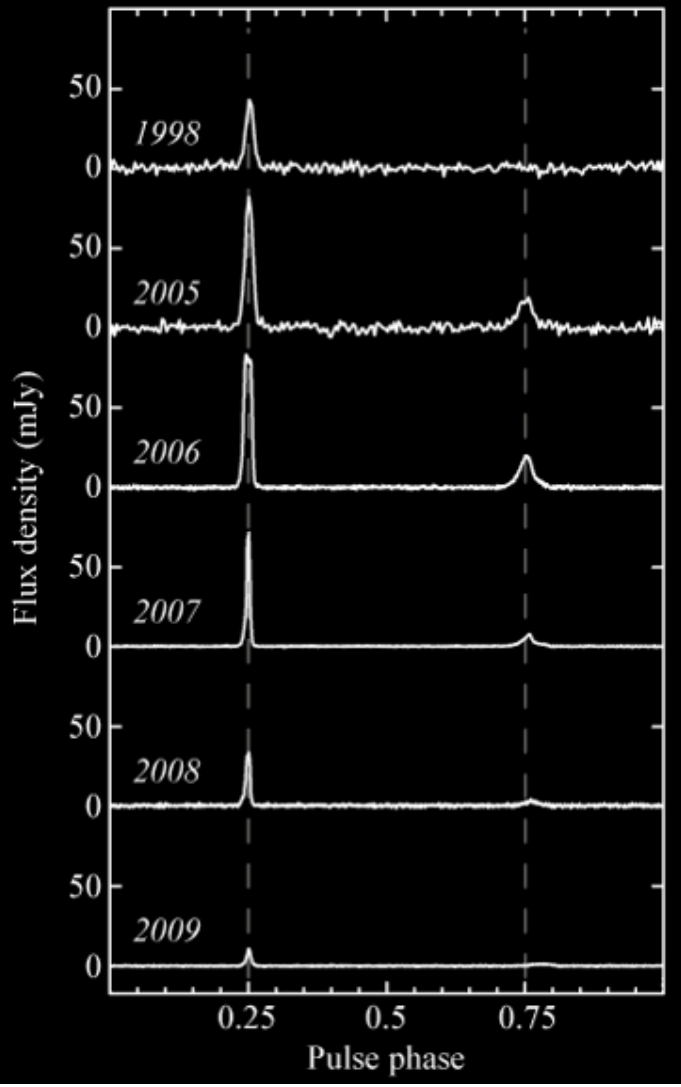


The Discovery of PSR J1906+0746

Found in 2-min integration

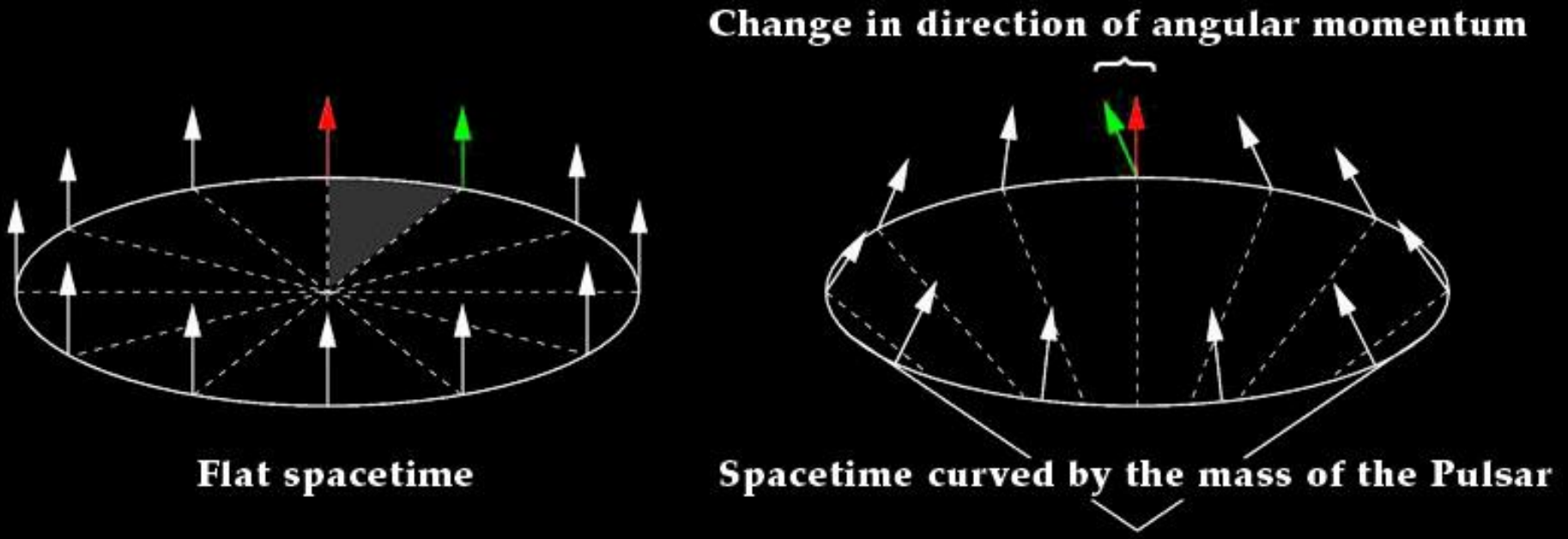
In a region of sky covered by Parkes Survey

Profile variation: geodetic precession



van Leeuwen et al. 2015, ApJ 798, 118

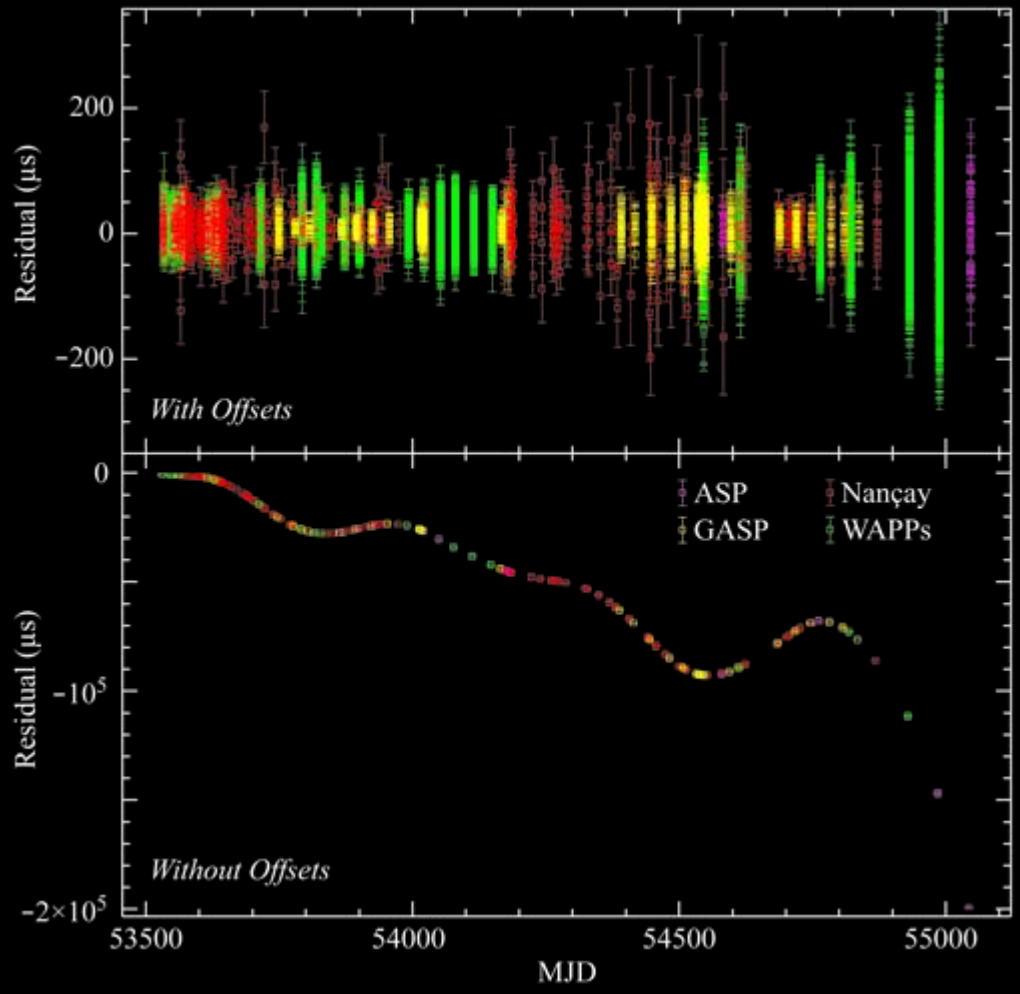
Geodetic precession:



Born to be wild

Relativistic effects buried under the jitters of youth.

Fortunately, the main GR time scale of interest is the 4-hr orbit.



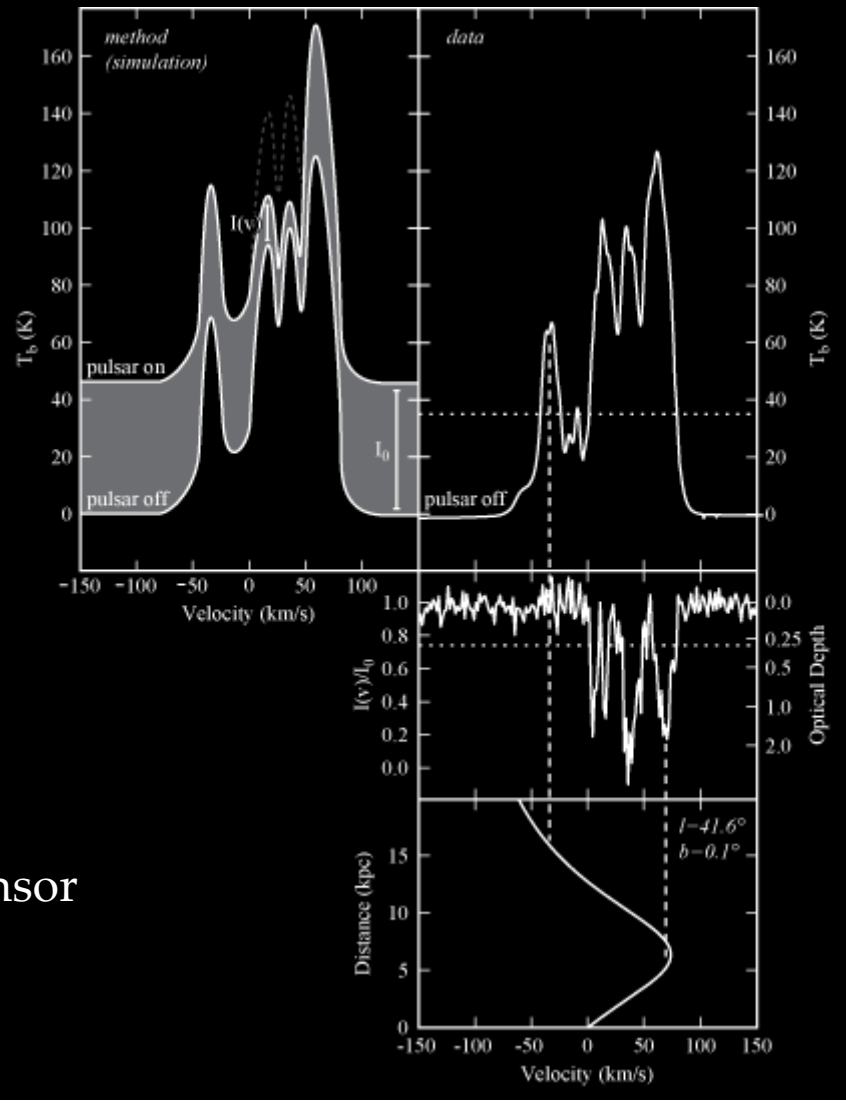
Is the companion a white dwarf?

Young pulsars *are* possible around older white dwarfs (e.g. J1141−6545).

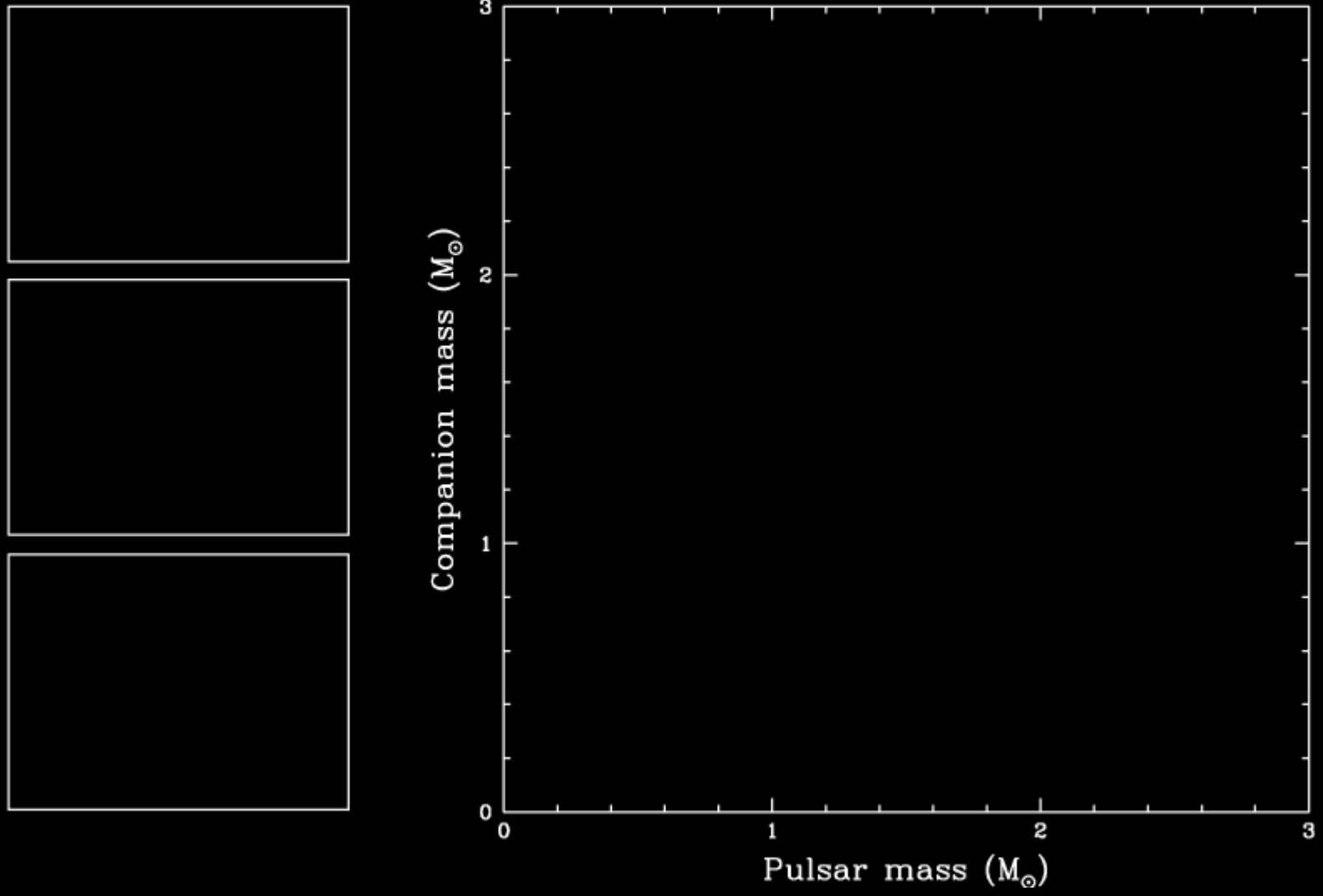
Observe the WD companion optically?
Very low Galactic latitude.
Distance from HI-absorption: 7.4 kpc
Optical WD identification very hard.

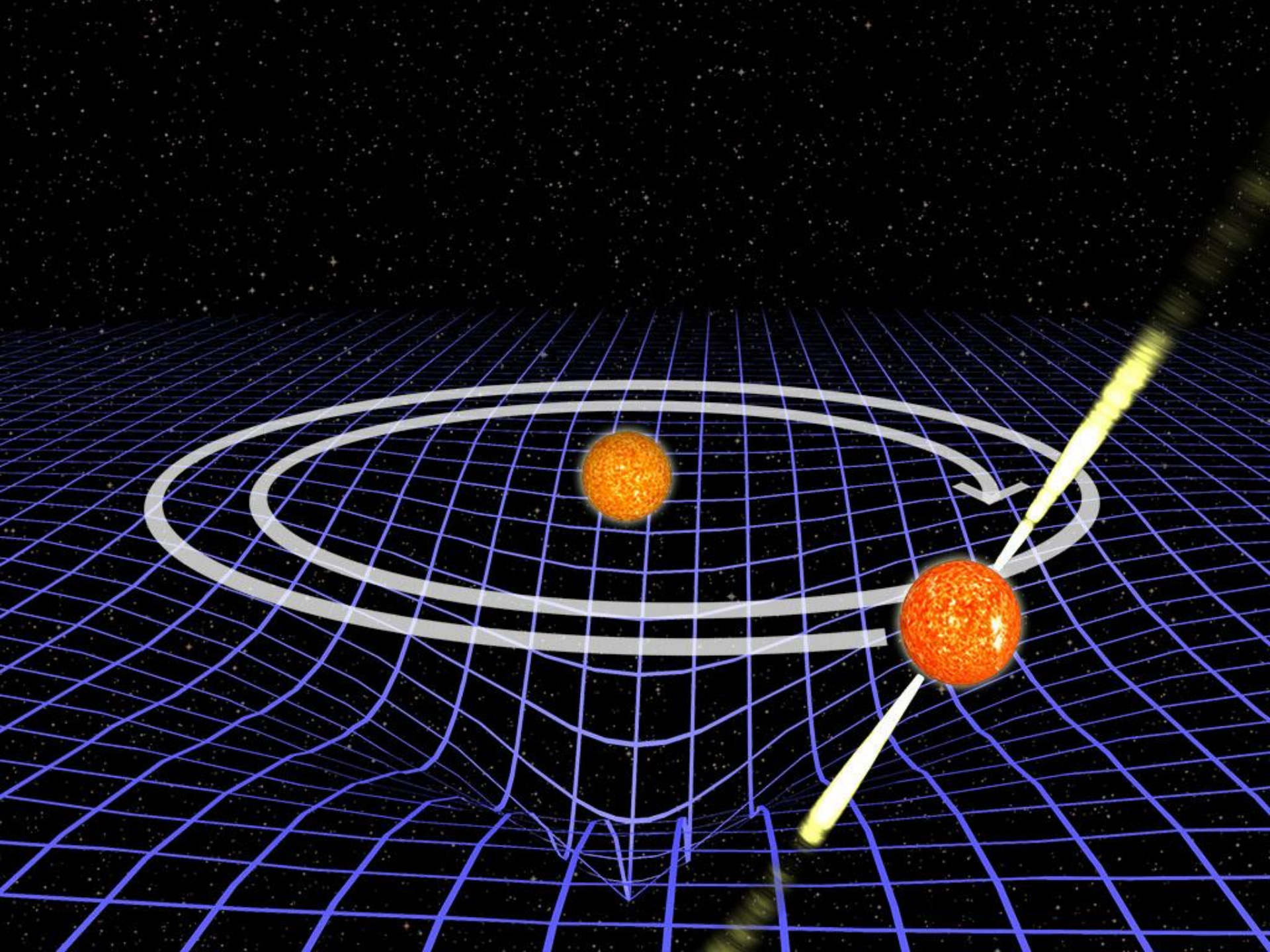
No radio pulsations from pulsar companion.
No outflow/eclipses from WD companion.

The high WD-NS potential for testing Scalar-Tensor theories is limited by the geodetic precession.

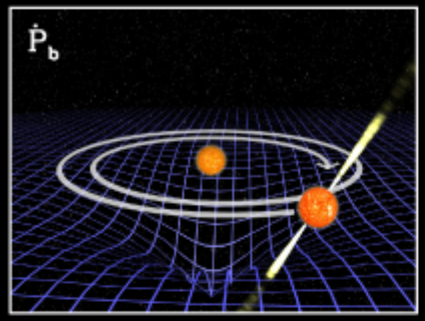


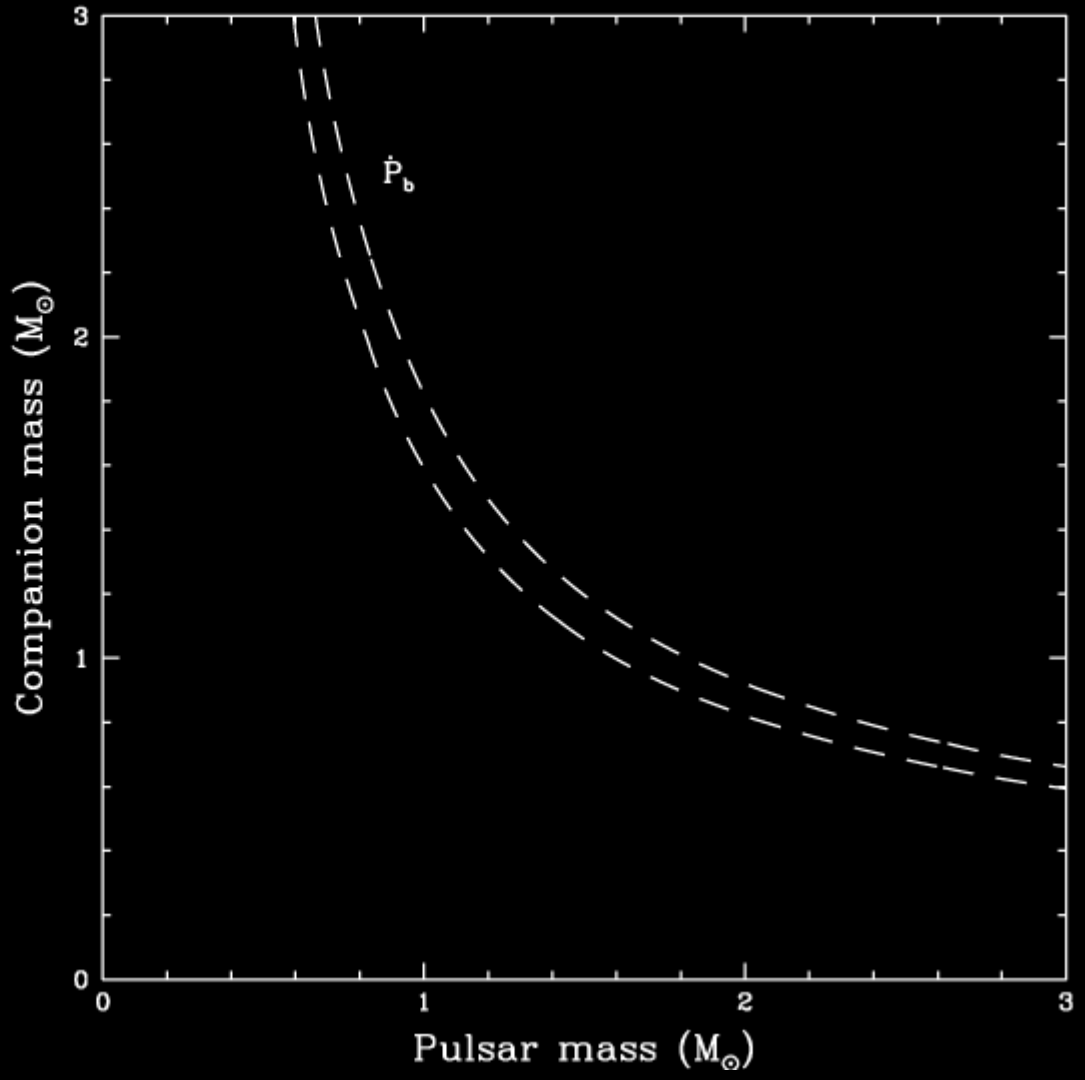
Post-Keplerian parameters & mass determination

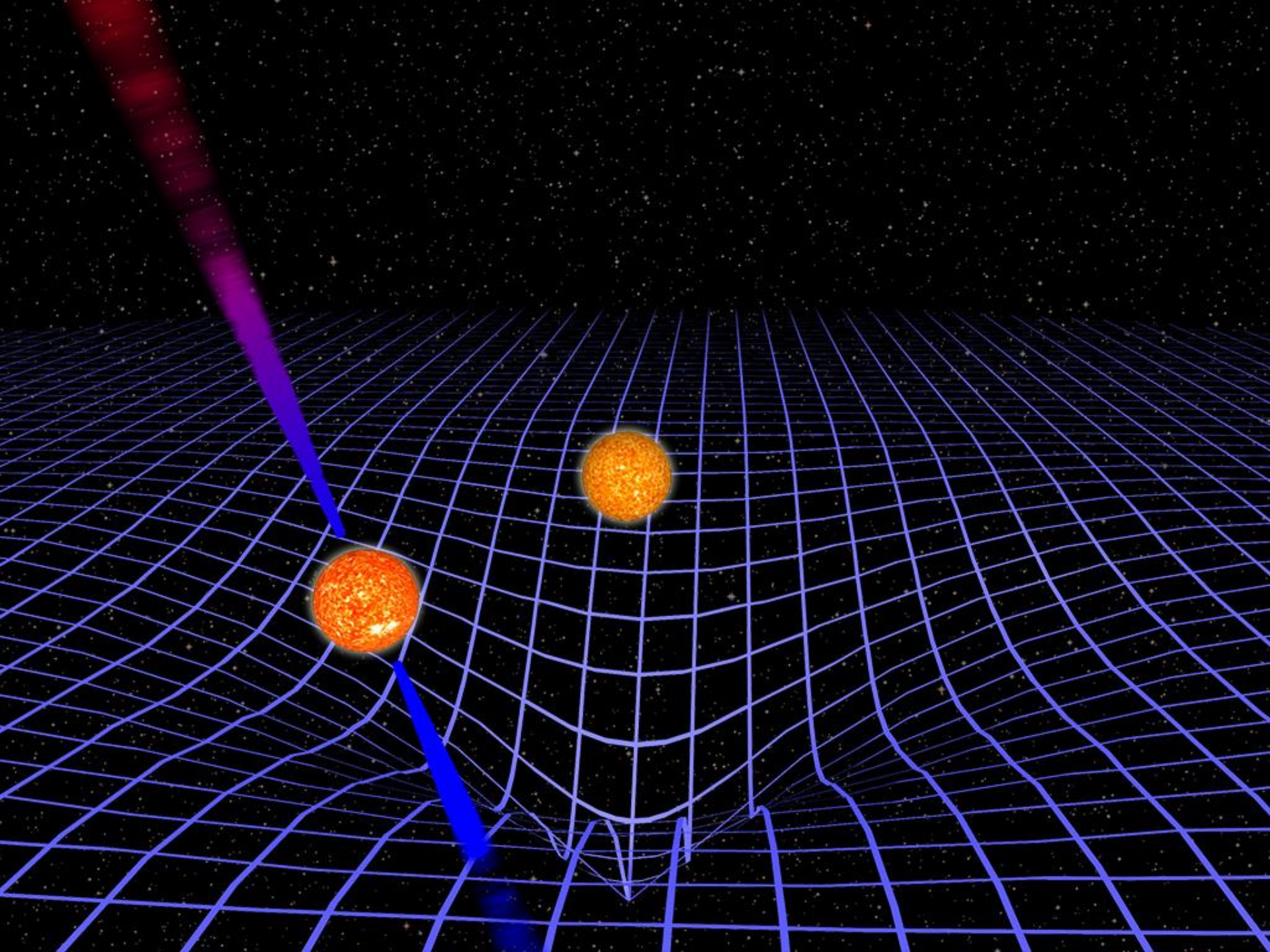




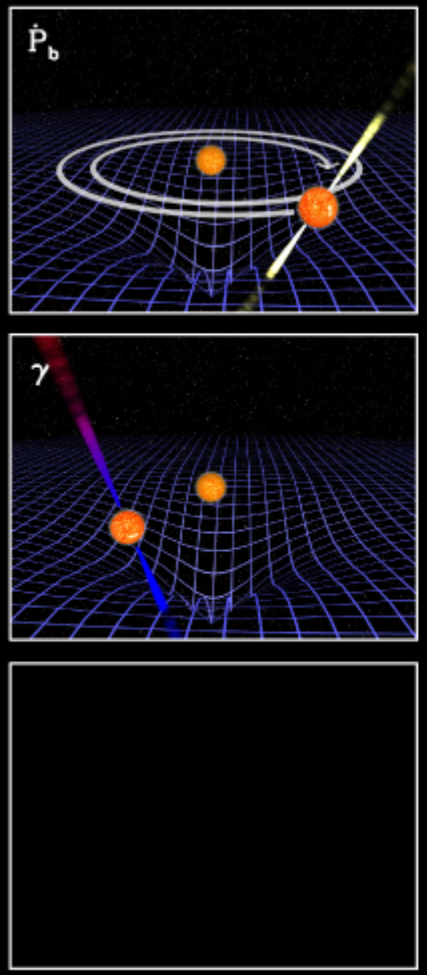
Post-Keplerian parameters & mass determination

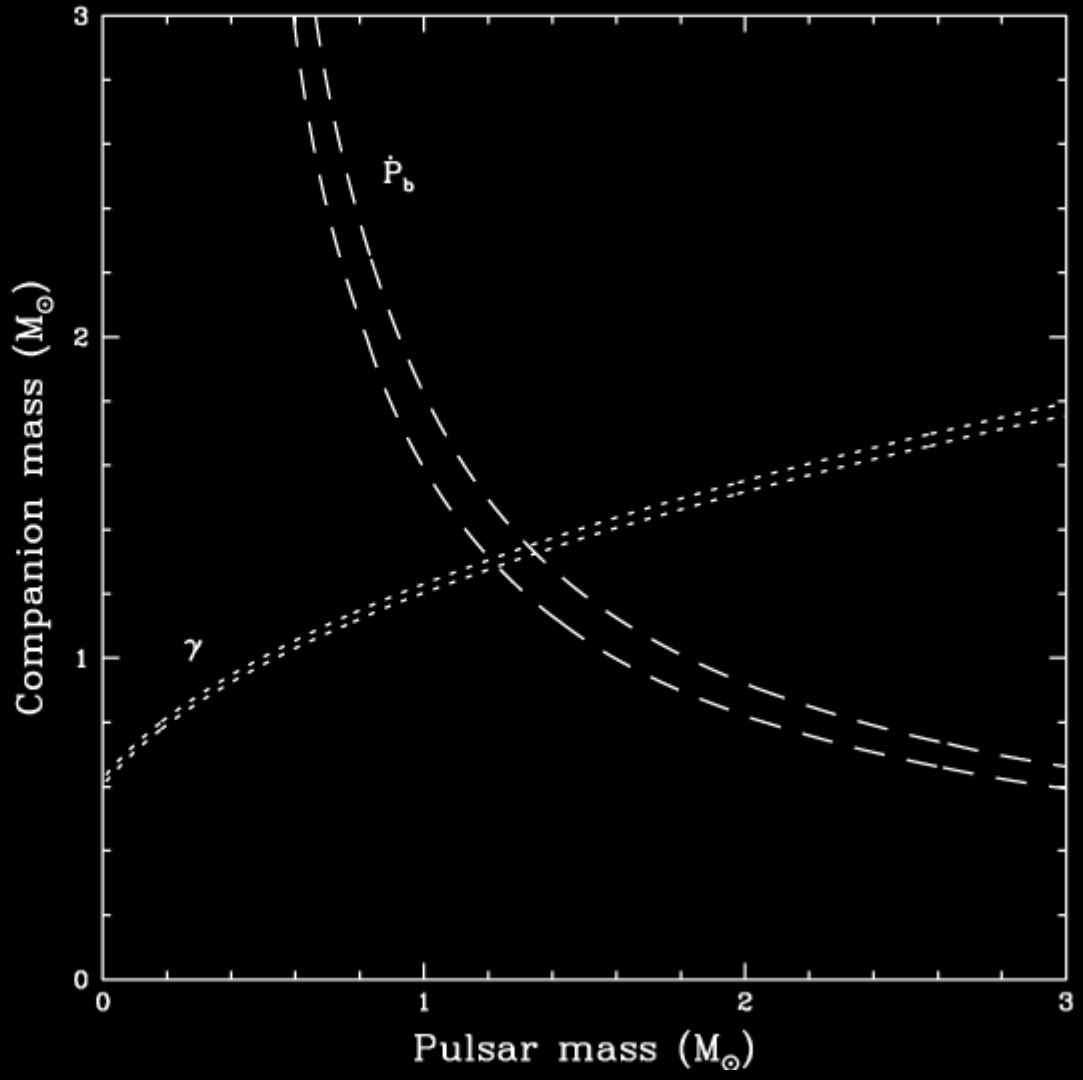


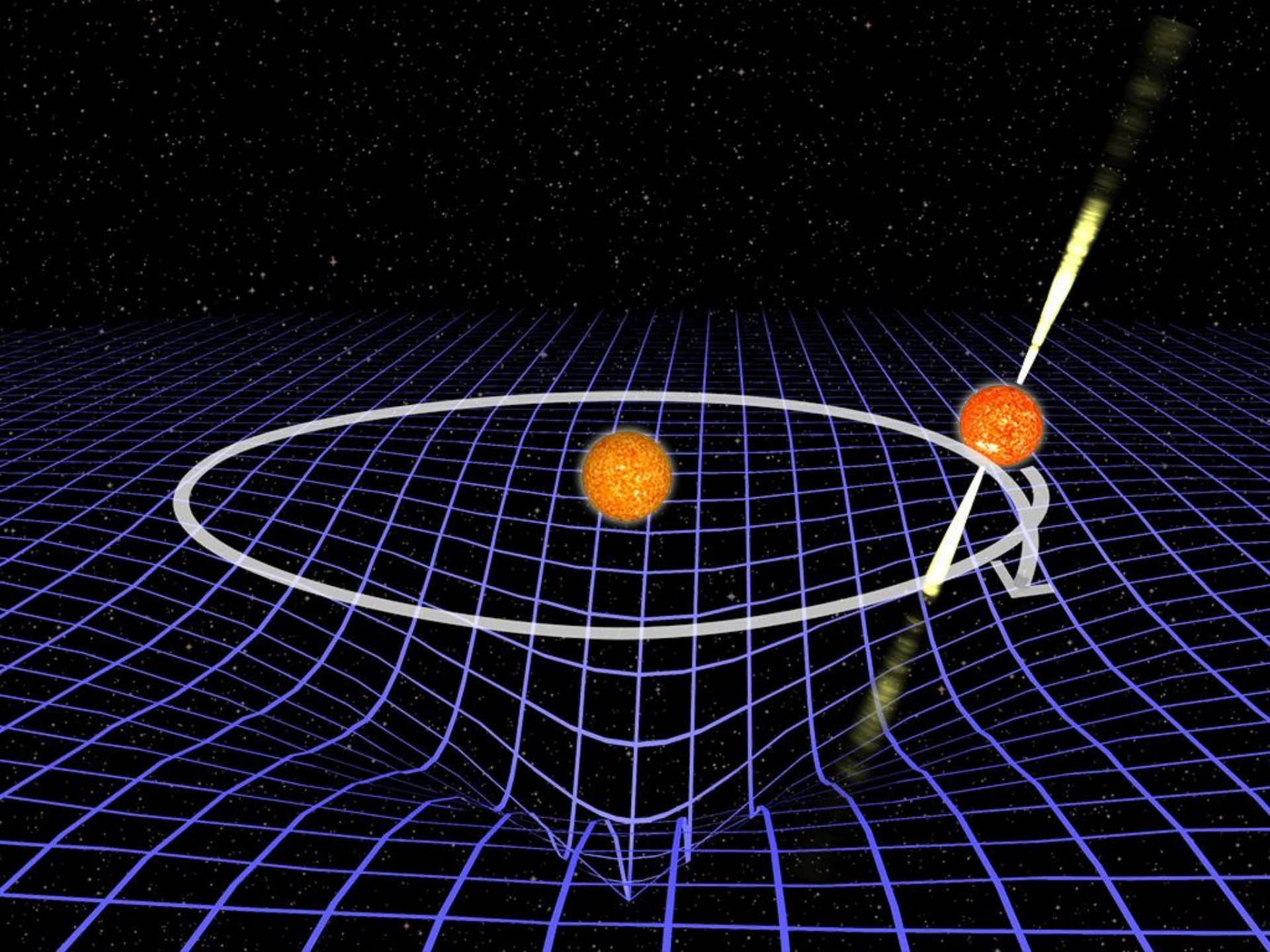




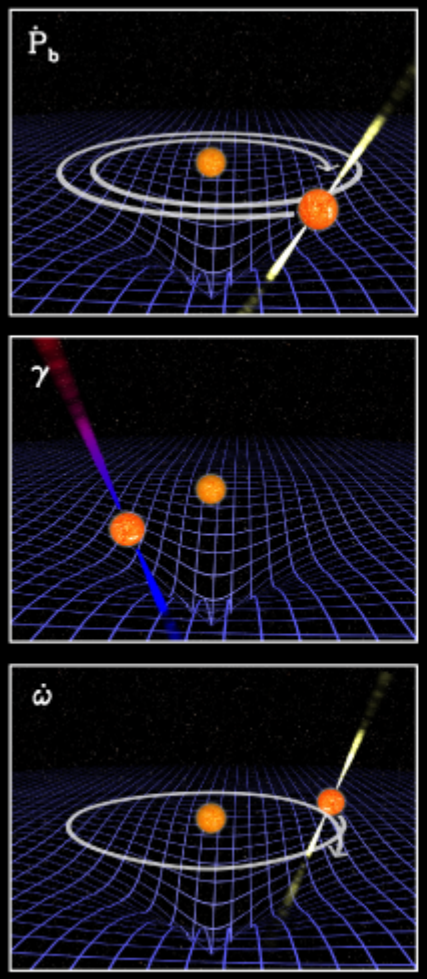
Post-Keplerian parameters & mass determination

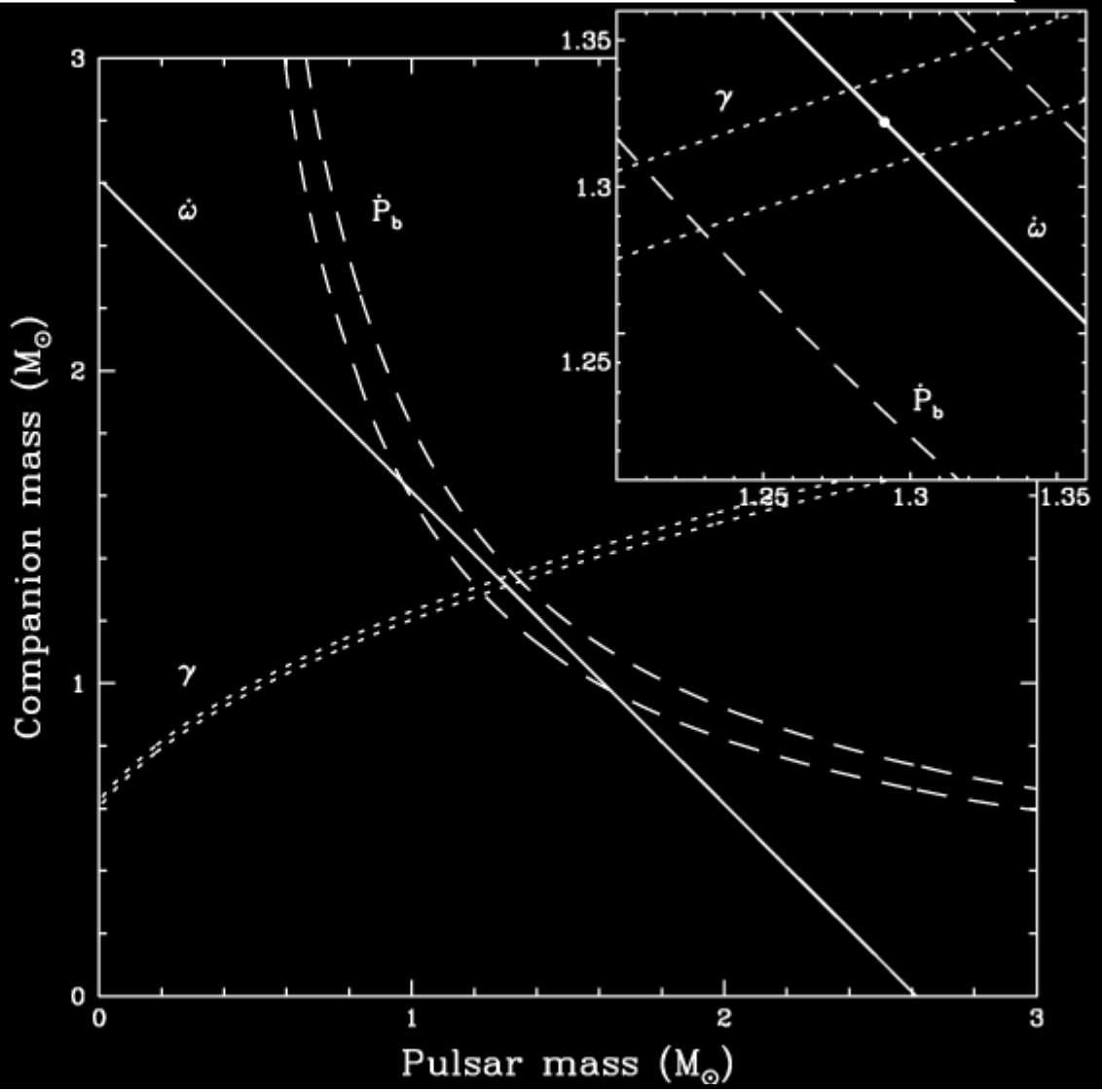






Post-Keplerian parameters & mass determination





van Leeuwen et al. 2015, ApJ 798, 118

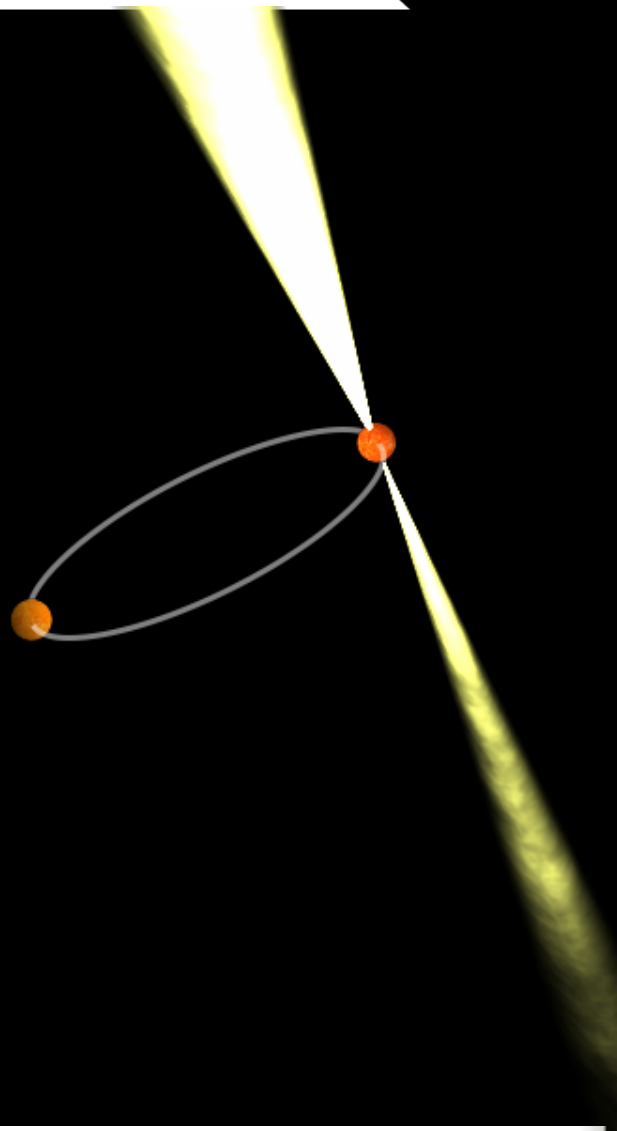
The companion to J1906+0746

Masses are = 1.291(11)$M_\odot$ for the pulsar and 1.322(11)$M_\odot$ for the companion.

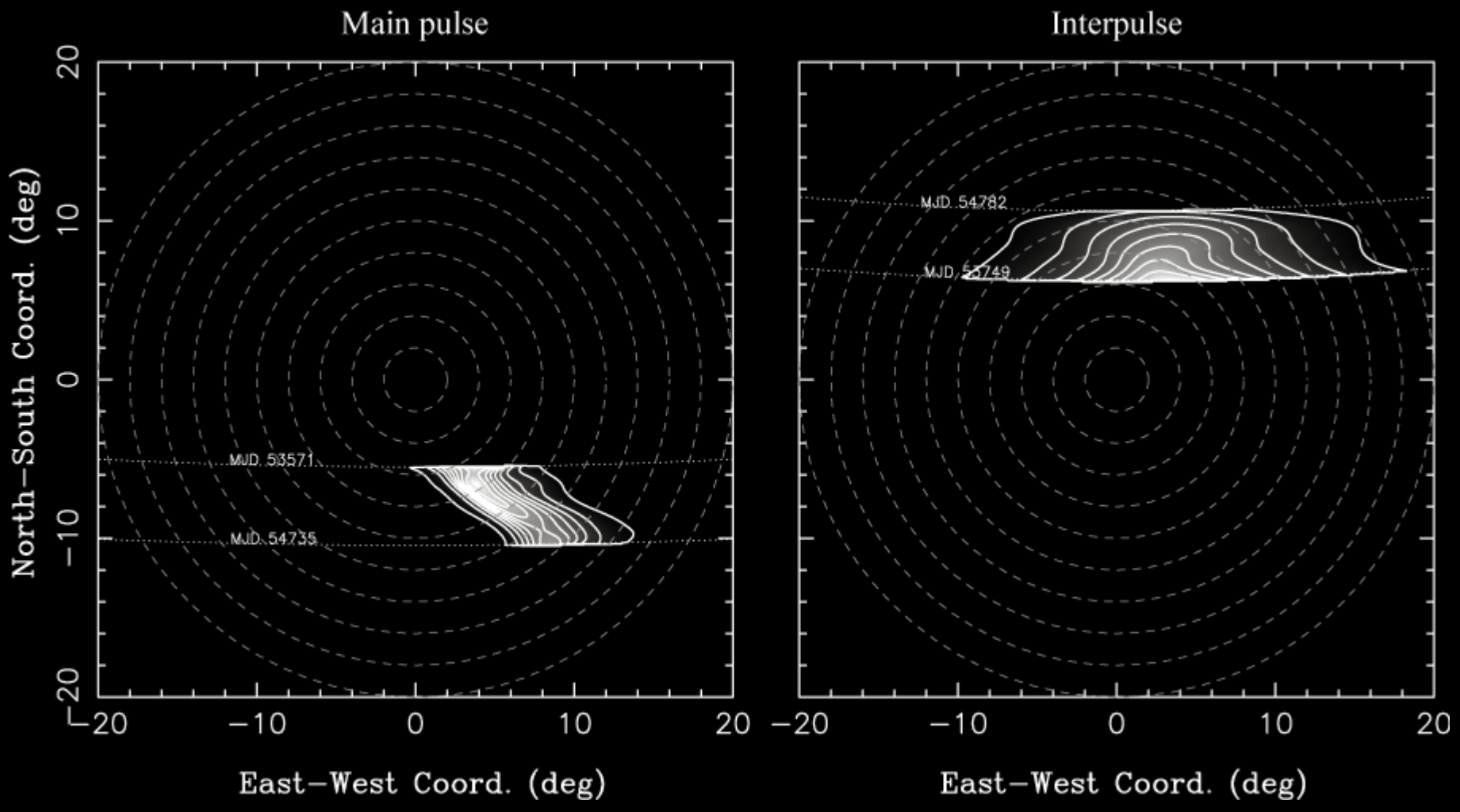
These masses fit best for double neutron stars, but companion could also still be a white dwarf.

Only in a handful of other double neutron stars have masses been measured, and J1906+0746 is by far the youngest.

These masses predict a geodetic precession of 2.2 degrees per year.



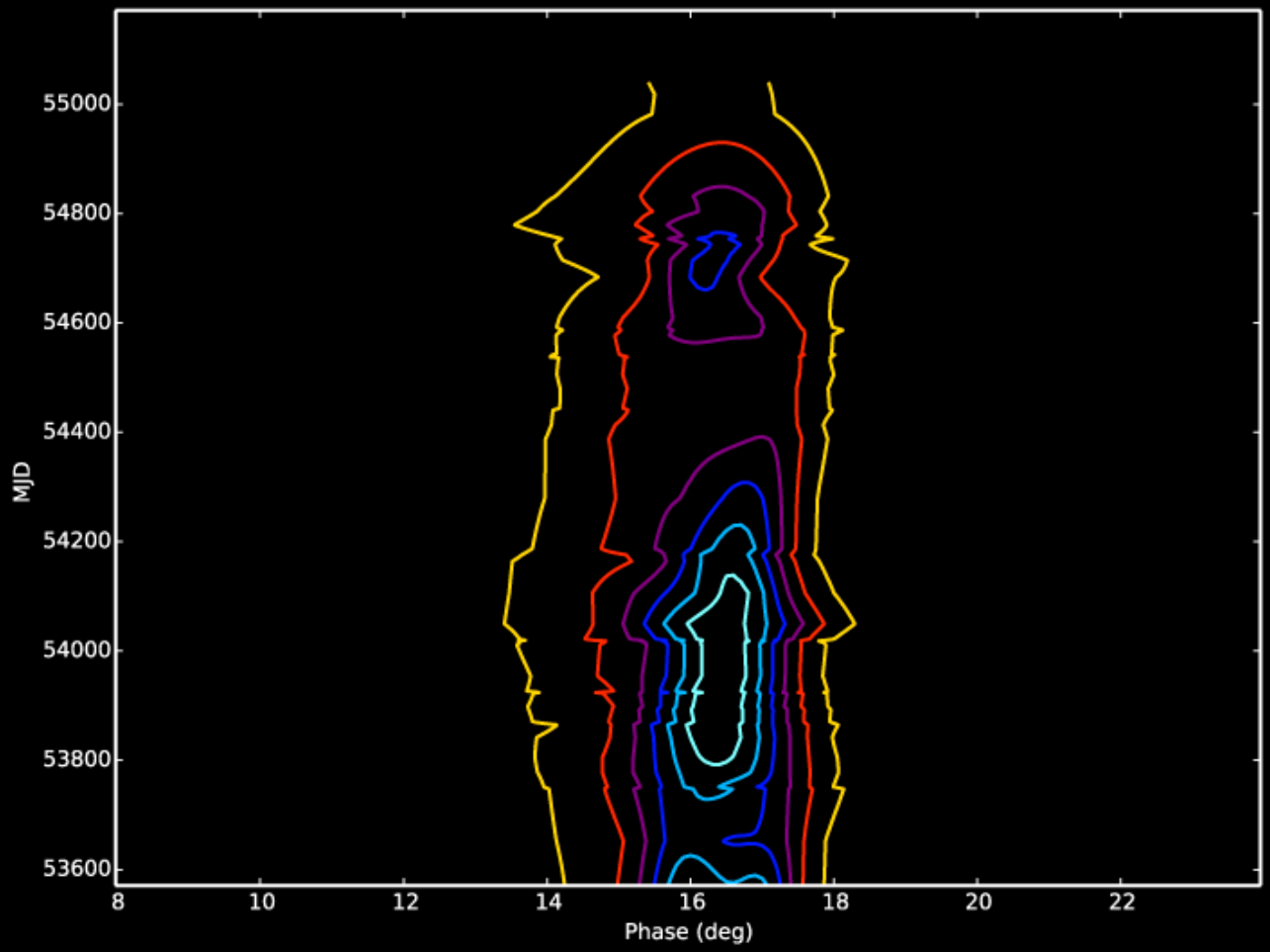
Geodetic Precession and Beam Mapping



Desvignes, et al. 2016 (*in prep.*)

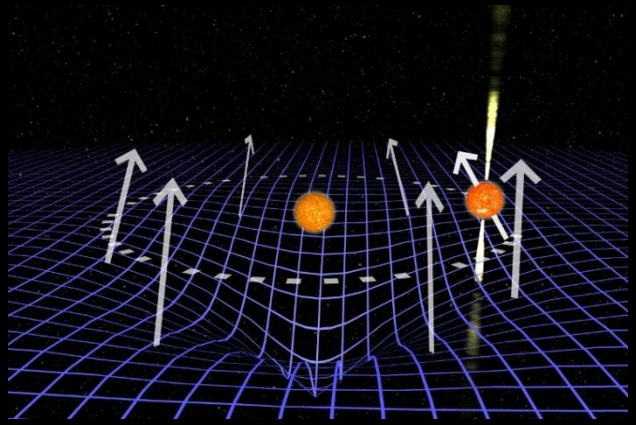
Geodetic Precession and Beam Mapping

Main pulse:



Desvignes, et al. 2016 (*in prep.*)

Conclusions

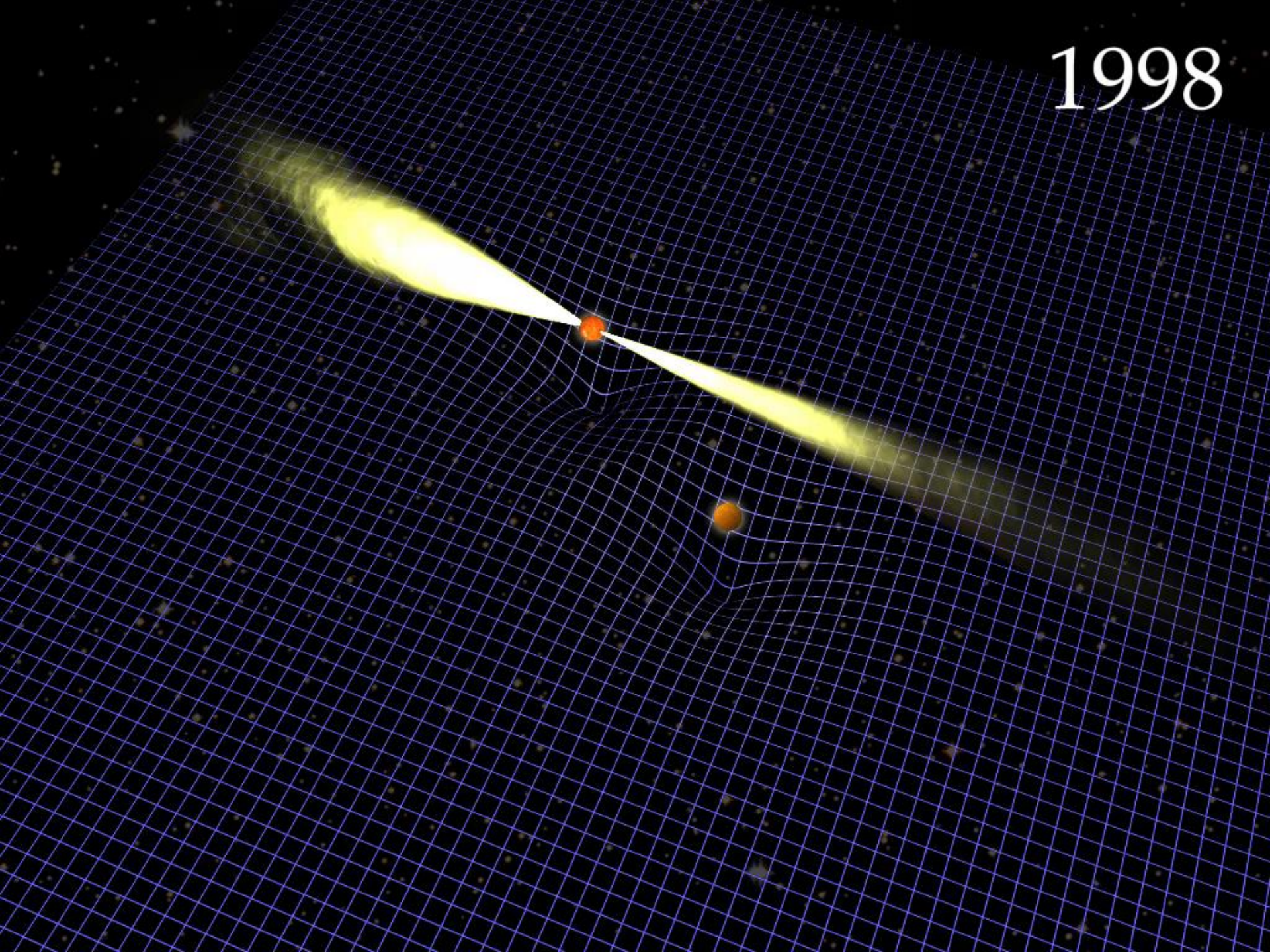


Measurement of 3 post-Keplerian parameters:
pulsar mass 1.29 $M_\odot$ & companion mass 1.32 $M_\odot$

J1906+0746 is likely part of a DNS, or is otherwise orbited by an older WD, in an exotic system formed through two stages of mass transfer.

The pulsar is fading fast due to geodetic precession, limiting future timing improvements.

The first time such a young pulsar has vanished – these labs come and go.


1998