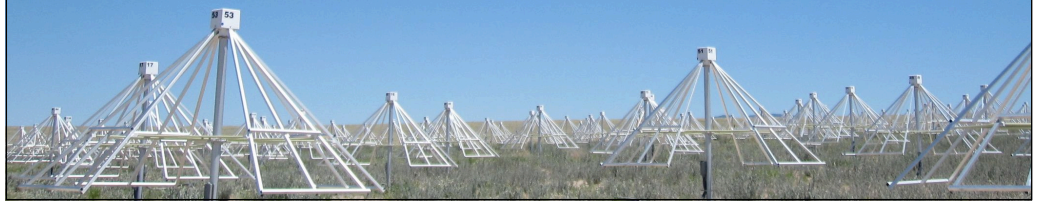
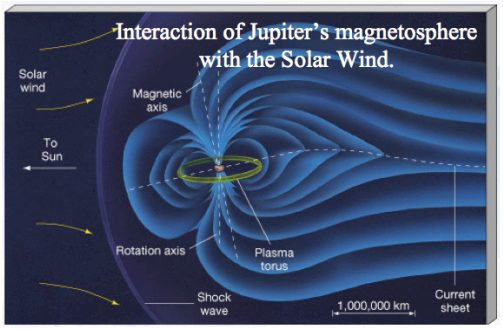
Hot Jupiter Detection Experiment (HJUDE)

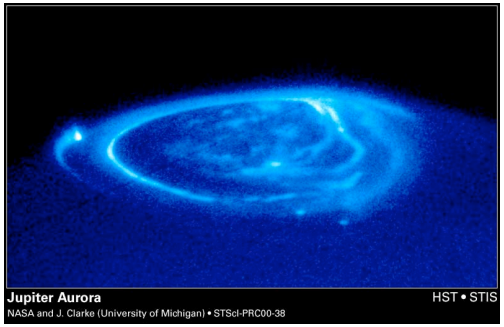
Jake Hartman (JPL)

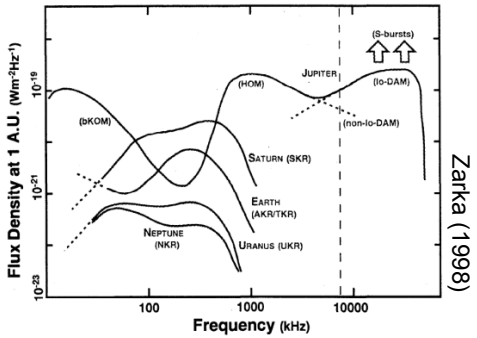
PIs: G. Hallinan,
G. Taylor, S. Ellingson



From our Jupiter …



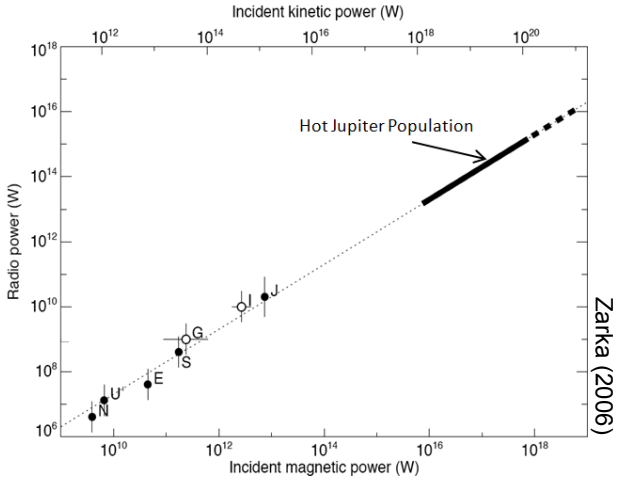




Zarka (1998)

LWA
Long Wavelength Array

… to Hot Jupiters



LWA
Long Wavelength Array

List of targets

Planet	d (pc)	a (AU)	$P_{\rm orb}$ (d)	M ($M_{\rm J}$)	e	ecl?	Best month
Hot Jupiters likely to be tidally locked:							
υ And b	13.49	0.059	4.62	1.4	0.013	N	Sep
τ Boo b	15.62	0.048	3.31	6.5	0.023	N	Mar
HD 189733 b	19.45	0.031	2.22	1.13	0.004	Y	Jun
HD 187123 b	48.26	0.042	3.10	$>$ 0.51	0.01	N	Jun
HD 209458 b	49.63	0.047	3.52	0.69	0.001	Y	Aug
Hot Jupiters less likely to be tidally locked:							
55 Cnc b	12.34	0.116	14.65	$>$ 0.84	0.016	N	Dec
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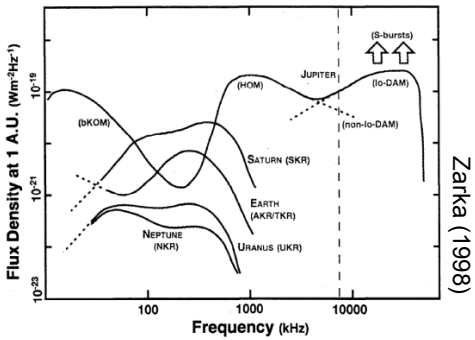
HD 80606 b	58.40	0.449	111.44	$>$ 3.94	0.934	Y	Dec

LWA
Long Wavelength Array

Emission from Hot Jupiters

- Low frequency:
  $eB / 2\pi m_e$ = 28 MHz at 10 G
- Bright!
  ~100 mJy fluxes predicted
  (but less than confusion)
- High circular polarization:
  LWA1 is very good at this!
- Predictably time-variable:
  - pulsar-like emission
  - secondary eclipses
  - periastron passages of high-eccentricity HJs
- However, substantial observing time is required for good upper limits



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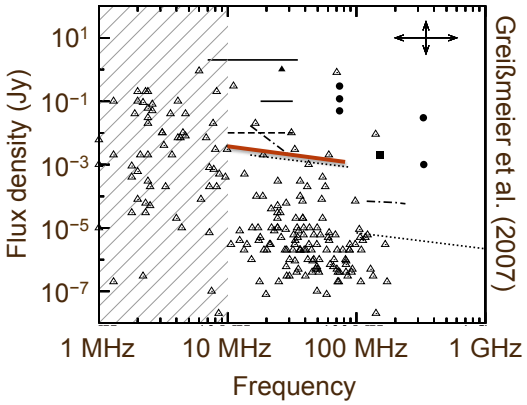

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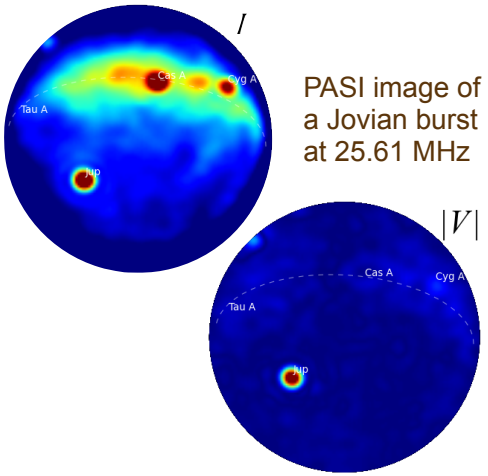

PASI image of a Jovian burst at 25.61 MHz

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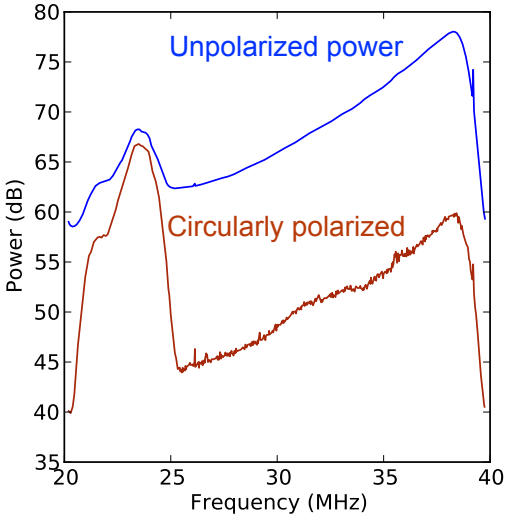

(absolute *V*, without calibration!)

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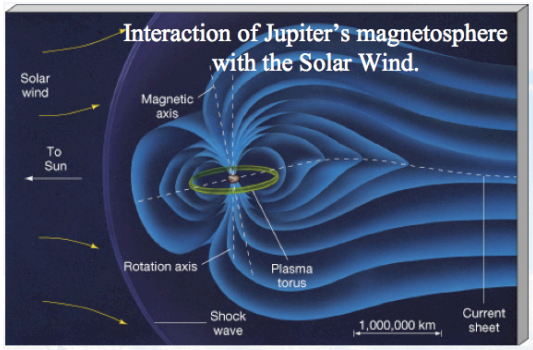

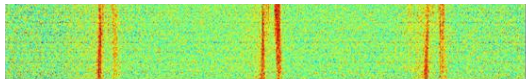

Time (6 hr total) →

Pulsing brown dwarf at 6.9–7.8 GHz
(Hallinan et al. 2012)

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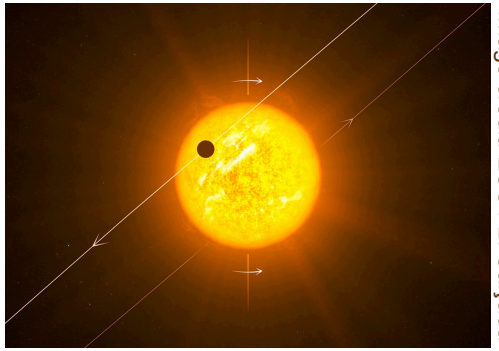

Image credit: ESO / L. Calçada

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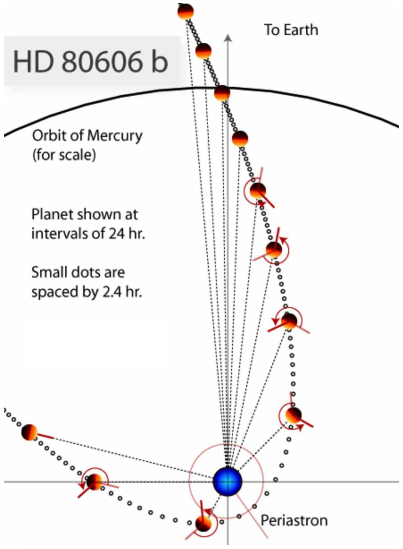

Image credit: G. Laughlin

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Observations processed to date

~300 wall hours taken

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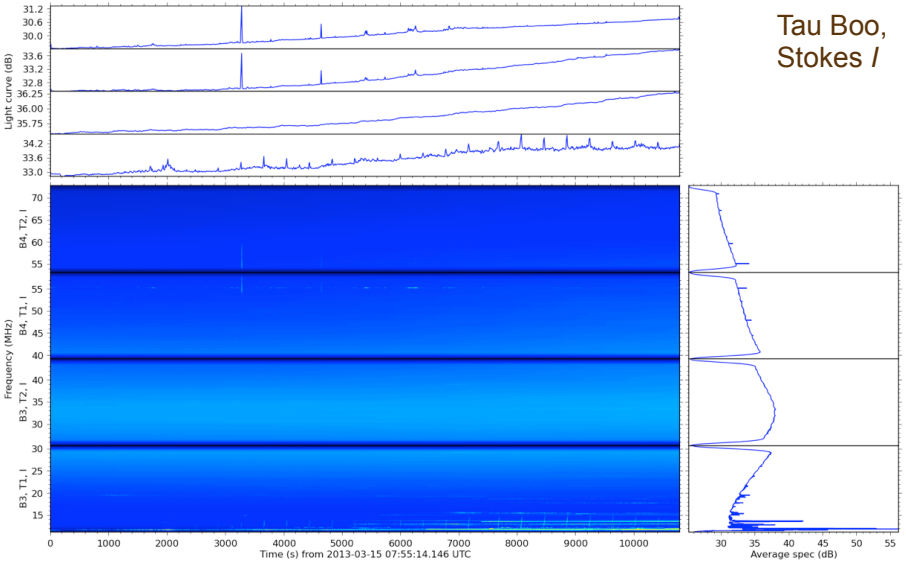
Tau Boo observations

Light curves

Frequency: 12 – 73 MHz



Tau Boo,
Stokes *I*

Time: 01:55 – 04:55 MDT, March 15, 2013

Avg spec: 25 – 56 dB

LWA
Long Wavelength Array

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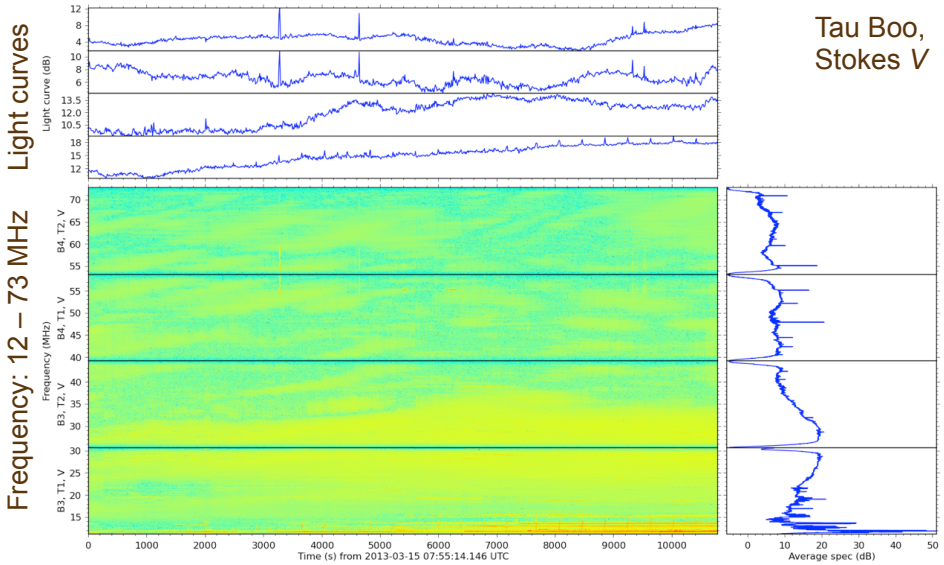
Light curves

Frequency: 12 – 73 MHz



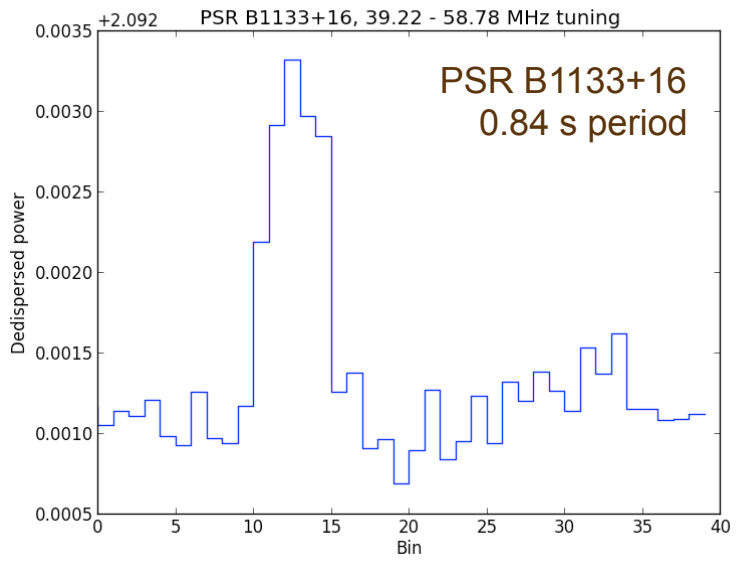
Tau Boo,
Stokes *V*

Time: 01:55 – 04:55 MDT, March 15, 2013

Avg spec: −6 – 51 dB

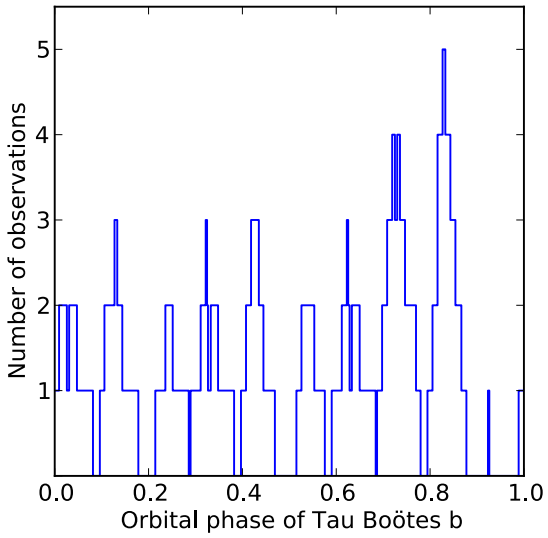
LWA
Long Wavelength Array

Tau Boo observations



Tau Boo observations

98.7 hours taken in March 2013
55.0 hours look OK



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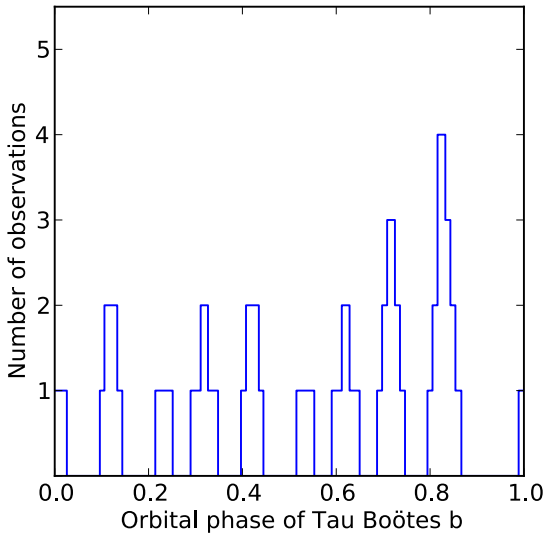

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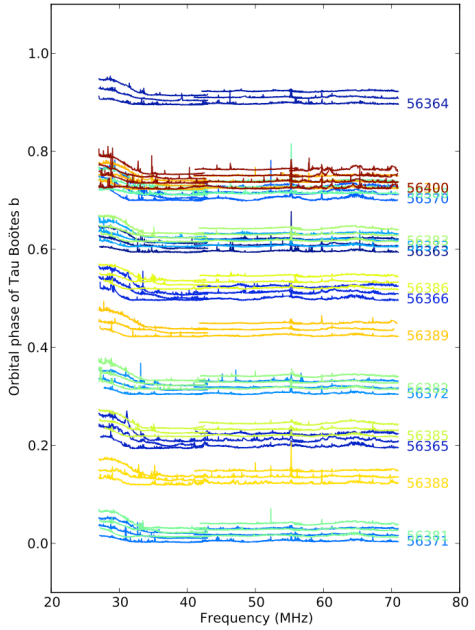

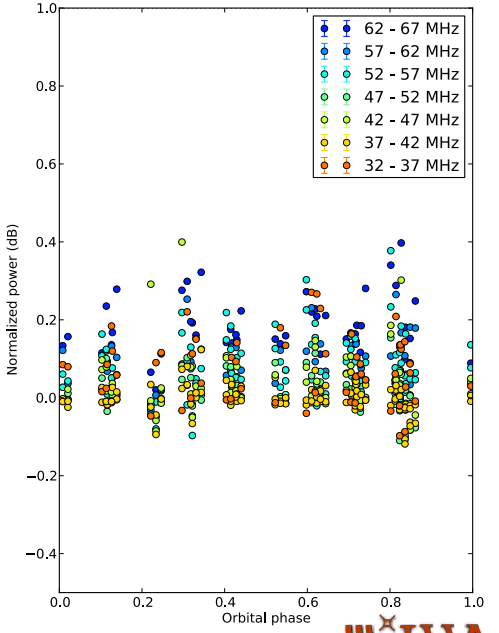

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Summary

- Hot Jupiters: a difficult but feasible target for LWA1
- Year 1 observations complete; upper limit for Tau Boo b pending
- Year 2 observations about to begin: targeting more sources, particularly at periastron and during secondary eclipses