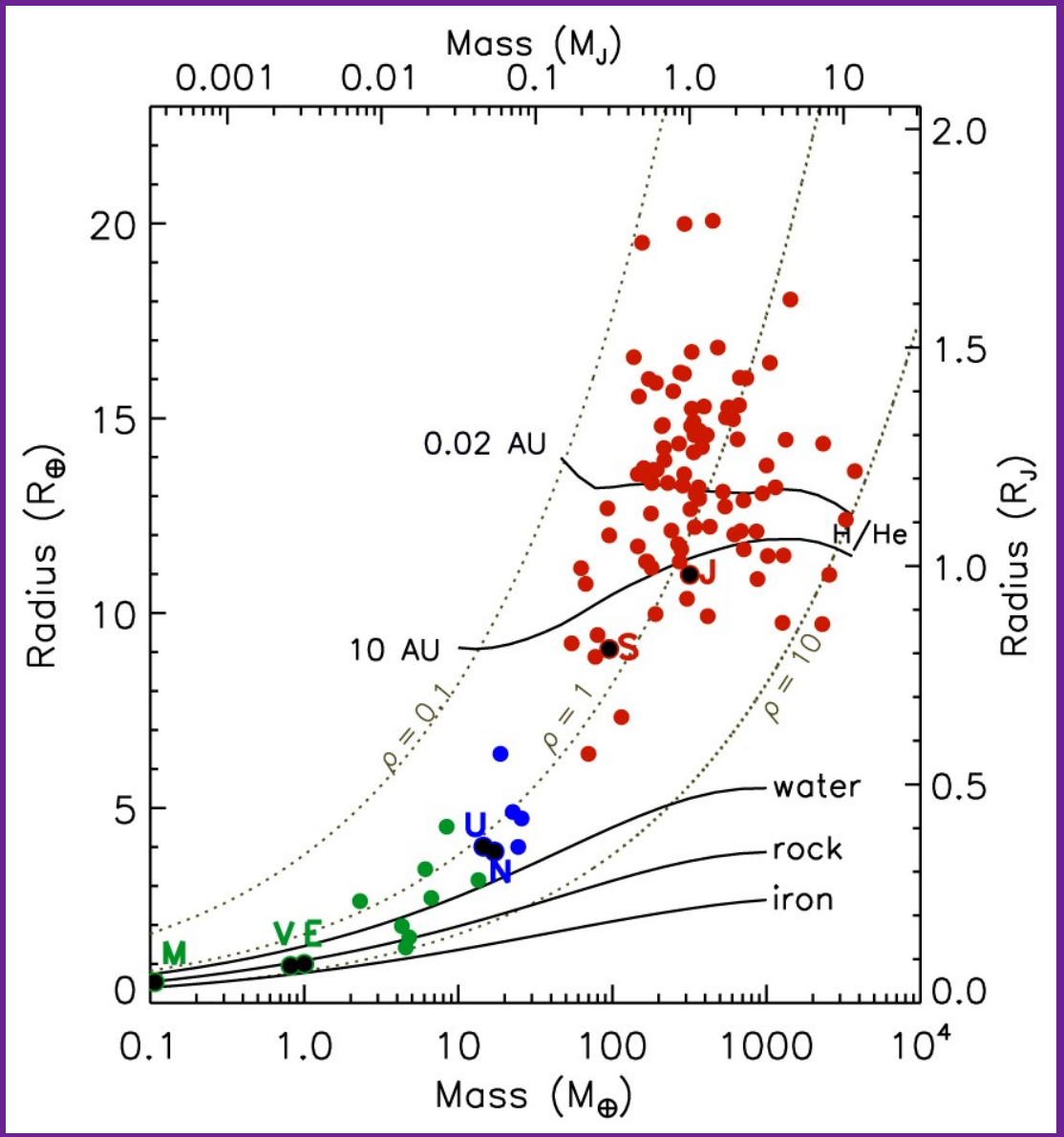
The Heavy Element Mass of Giant Exoplanets

arXiv:1105.0024

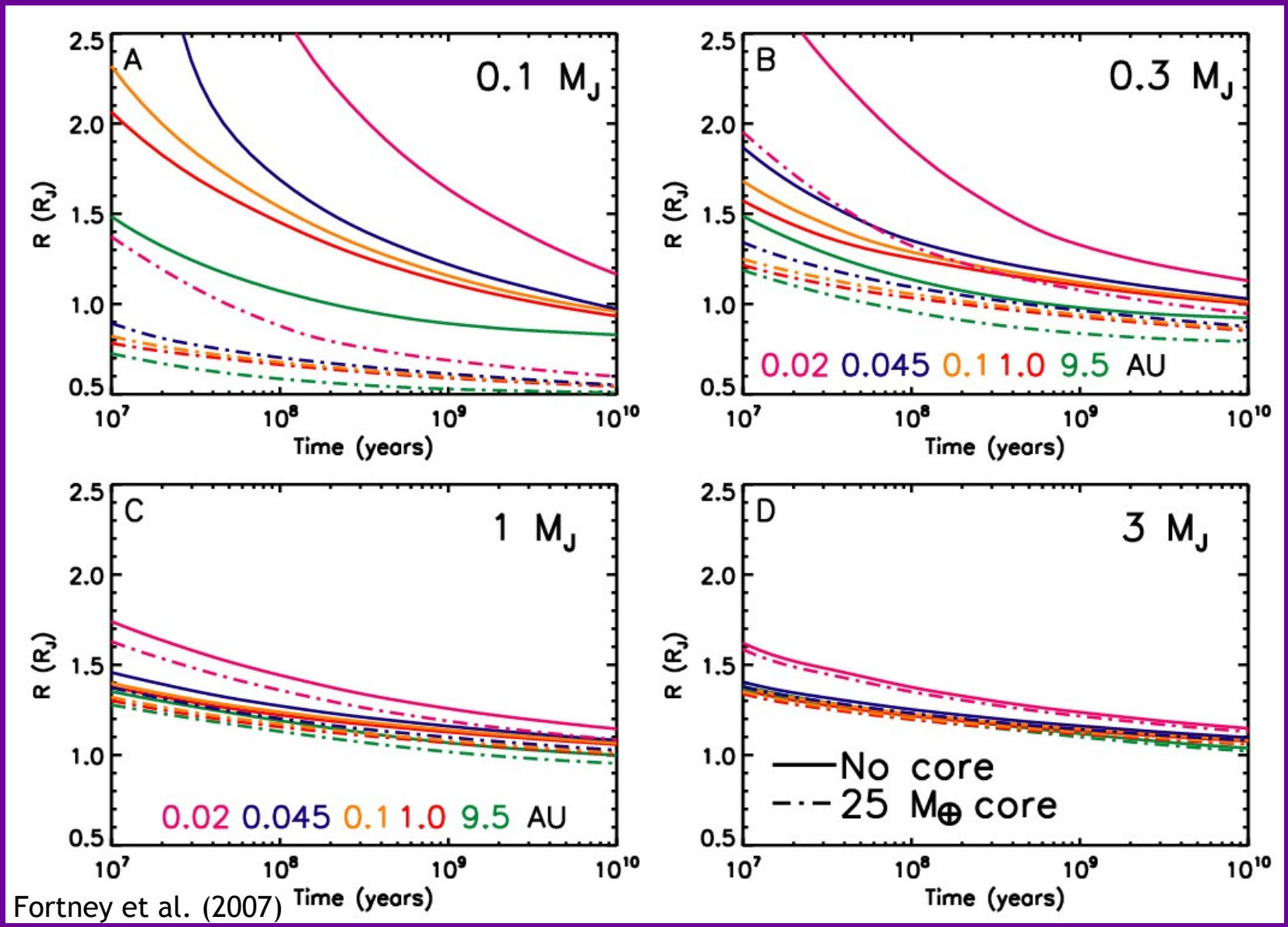


Neil Miller

University of California, Santa Cruz

Thanks to: Jonathan Fortney (UCSC), Eric Lopez (UCSC)

At Gyr ages, ~1.3 R_J is the largest radius of a standard cooling model



Fortney et al. (2007)

Evolution of "51 Pegasus b-like" planets

T. Guillot[1] and A. P. Showman[2]

THE MECHANICAL GREENHOUSE: BURIAL OF HEAT BY TURBULENCE IN HOT JUPITER ATMOSPHERES

Andrew N. Youdin[1] and Jonathan L. Mitchell[2]
[1] Canadian Institute for Theoretical Astrophysics, University of Toronto, 60 St. George Street, Toronto, Ontario M5S 3H8, Canada
[2] Department of Earth & Space Sciences and Department of Atmospheric and Oceanic Sciences, University of California Los Angeles, 595 Charles Young East Drive, Los Angeles, CA 90095-1567, USA
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ON THE TIDAL INFLATION OF SHORT-PERIOD EXTRASOLAR PLANETS[1]

Peter Bodenheimer,[2] D. N. C. Lin,[2] and R. A. Mardling[2,3]
Received 2000 May 17; accepted 2000 October 11

OBLIQUITY TIDES ON HOT JUPITERS

Joshua N. Winn[1] and Matthew J. Holman
Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138
Received 2005 May 13; accepted 2005 June 20; published 2005 July 15

THERMAL TIDES IN FLUID EXTRASOLAR PLANETS

Phil Arras[1] and Aristotle Socrates[2]
[1] Department of Astronomy, University of Virginia, P.O. Box 400325, Charlottesville, VA 22904-4325, USA; arras@virginia.edu
[2] Institute for Advanced Study, Einstein Drive, Princeton, NJ 08540, USA; socrates@ias.edu
Received 2009 August 7; accepted 2010 February 16; published 2010 April 6

The effect of evaporation on the evolution of close-in giant planets

I. Baraffe[1], F. Selsis[2], G. Chabrier[1], T. S. Barman[3], F. Allard[1], P. H. Hauschildt[4], and H. Lammer[5]

Explaining Large Radii

An area of active research!

POSSIBLE SOLUTIONS TO THE RADIUS ANOMALIES OF TRANSITING GIANT PLANETS

A. Burrows,[1] I. Hubeny,[1] J. Budaj,[1,2] and W. B. Hubbard[3]
Received 2006 December 22; accepted 2007 February 9

HEAT TRANSPORT IN GIANT (EXO)PLANETS: A NEW PERSPECTIVE

Gilles Chabrier and Isabelle Baraffe[1,2]
Received 2007 March 6; accepted 2007 March 28; published

INFLATING AND DEFLATING HOT JUPITERS: COUPLED TIDAL AND THERMAL EVOLUTION OF KNOWN TRANSITING PLANETS

N. Miller[1], J. J. Fortney[1], and B. Jackson[2]
[1] Department of Astronomy and Astrophysics, University of California, Santa Cruz, CA 95064, USA; neil@astro.ucsc.edu, jfortney@ucolick.org
[2] Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721, USA; bjackson@lpl.arizona.edu
Received 2009 May 4; accepted 2009 July 6; published 2009 August 21

TWO CLASSES OF HOT JUPITERS

Brad M. S. Hansen[1] and Travis Barman[2]
Received 2007 June 20; accepted 2007 August 23

TIDAL HEATING OF EXTRASOLAR PLANETS

Brian Jackson, Richard Greenberg, and Rory Barnes
Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721
Received 2007 December 5; accepted 2008 February 12

COUPLED EVOLUTION WITH TIDES OF THE RADIUS AND ORBIT OF TRANSITING GIANT PLANETS: GENERAL RESULTS

Laurent Ibgui and Adam Burrows
Department of Astrophysical Sciences, Peyton Hall, Princeton University, Princeton, NJ 08544, USA; ibgui@astro.princeton.edu, burrows@astro.princeton.edu
Received 2009 February 20; accepted 2009 June 4; published 2009 July 17

INFLATING HOT JUPITERS WITH OHMIC DISSIPATION

Konstantin Batygin and David J. Stevenson
Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125, USA; kbatygin@gps.caltech.edu
Received 2010 February 18; accepted 2010 March 23; published 2010 April 15

Inflated hot Jupiters from merger events

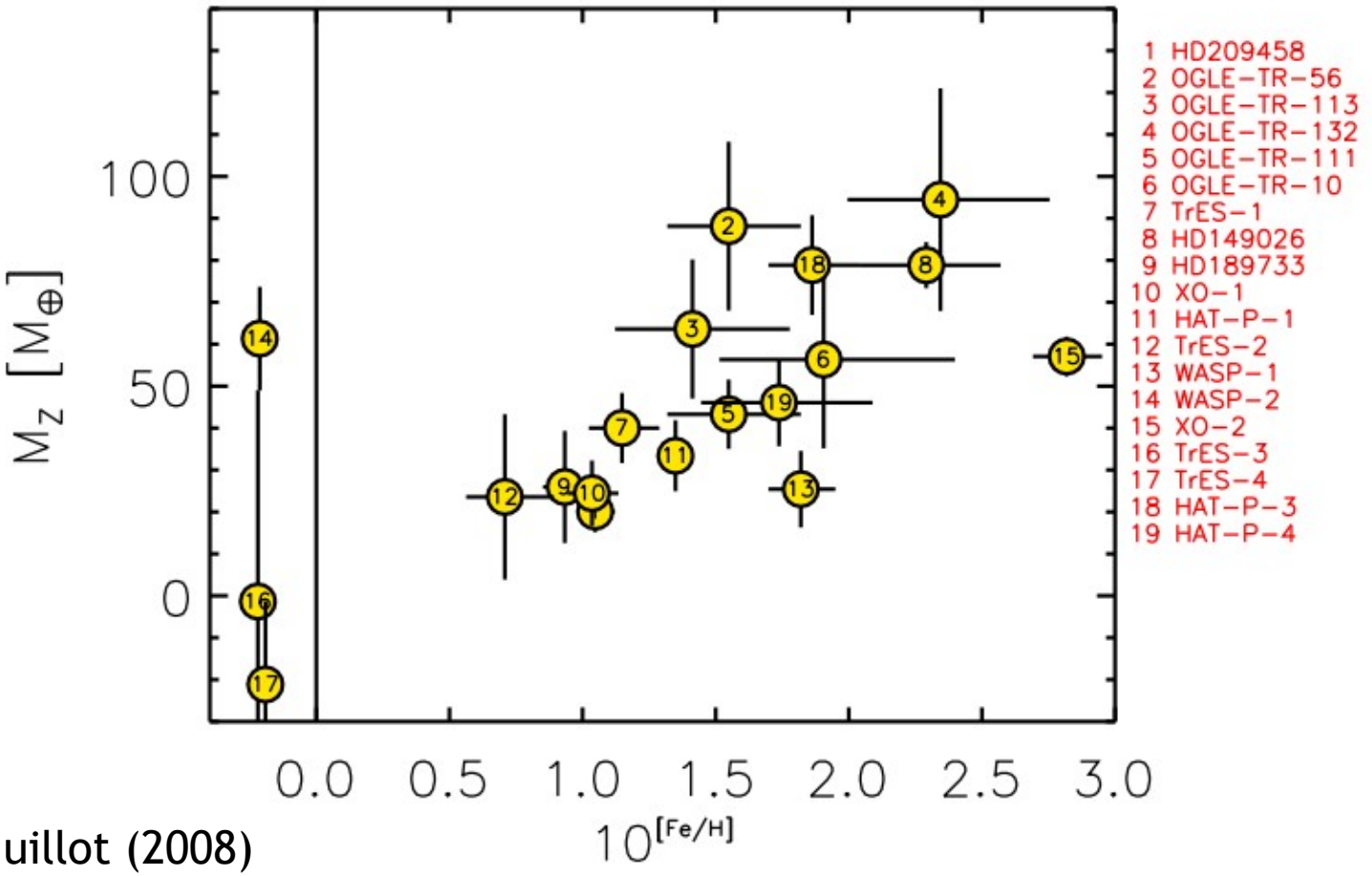
E. L. Martin[1], H. C. Spruit[2]

Is tidal heating sufficient to explain bloated exoplanets? Consistent calculations accounting for finite initial eccentricity

Jérémy Leconte[1], Gilles Chabrier[1], Isabelle Baraffe[1,2], and Benjamin Levrard[1]

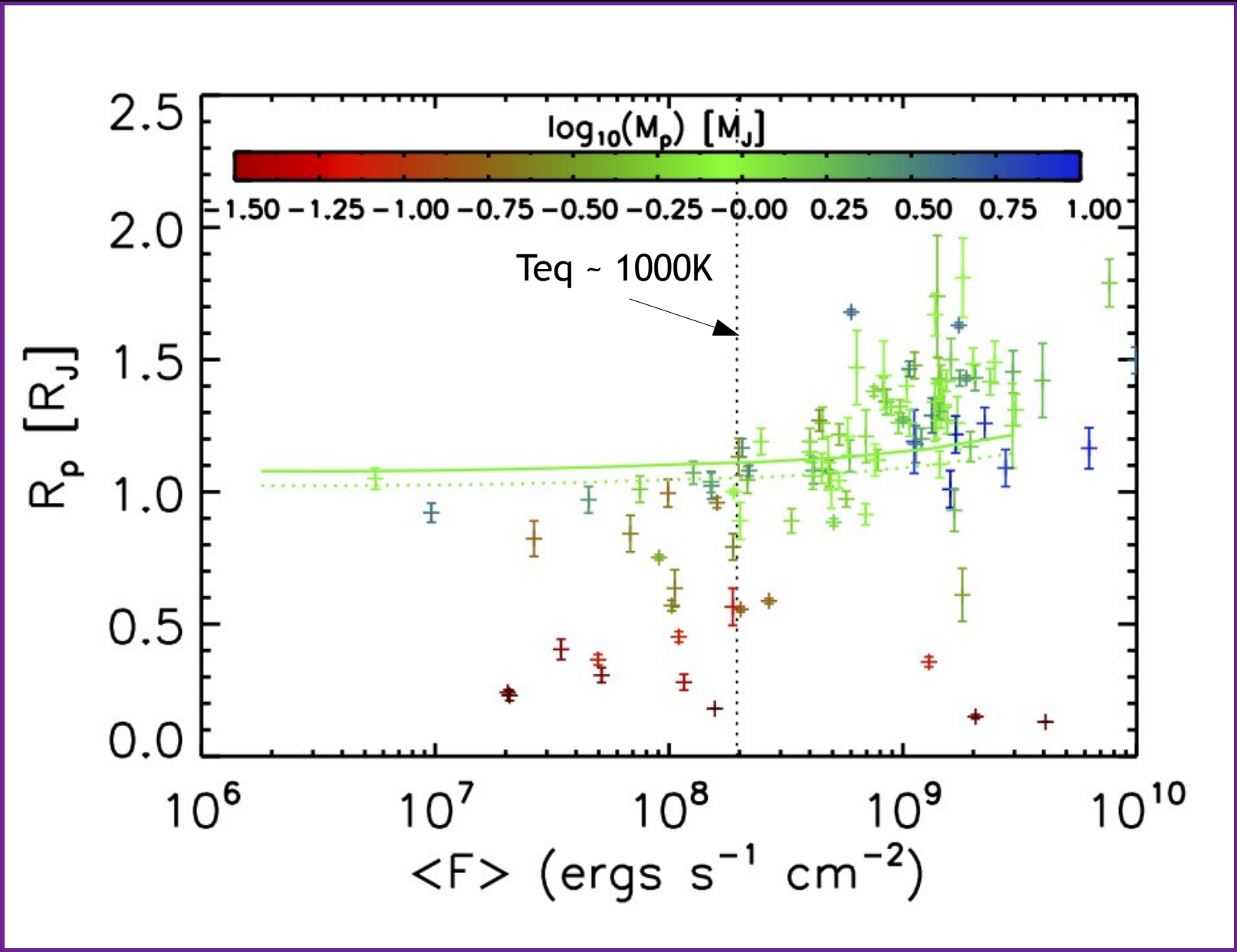
Assuming 0.5% of stellar flux heats the interior ...

The planet heavy mass can be inferred



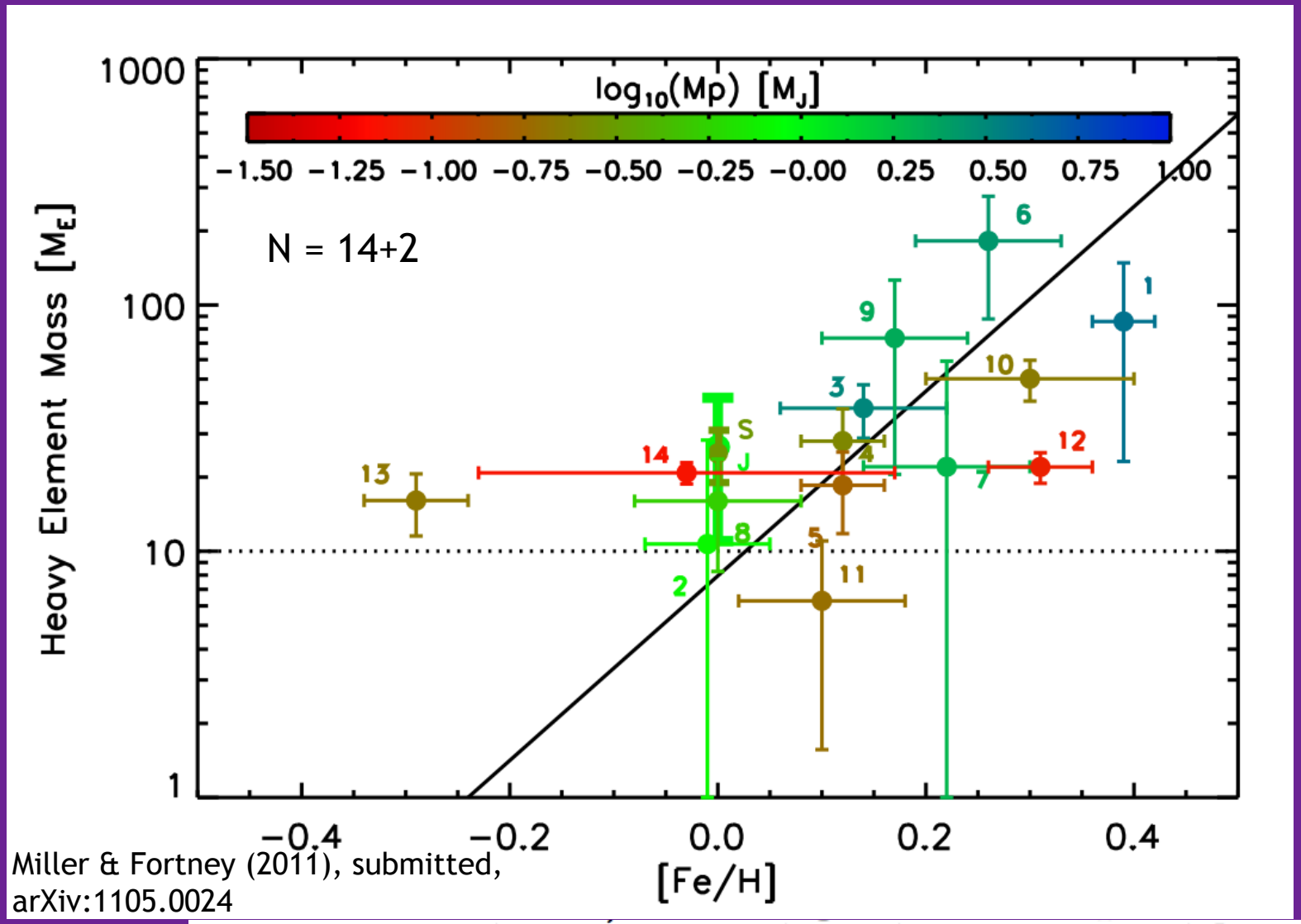
Guillot (2008)

There is an emerging subpopulation of planets with no radius anomaly!



Miller & Fortney (2011), submitted, arXiv:1105.0024

A strong correlation between the star and planet abundances

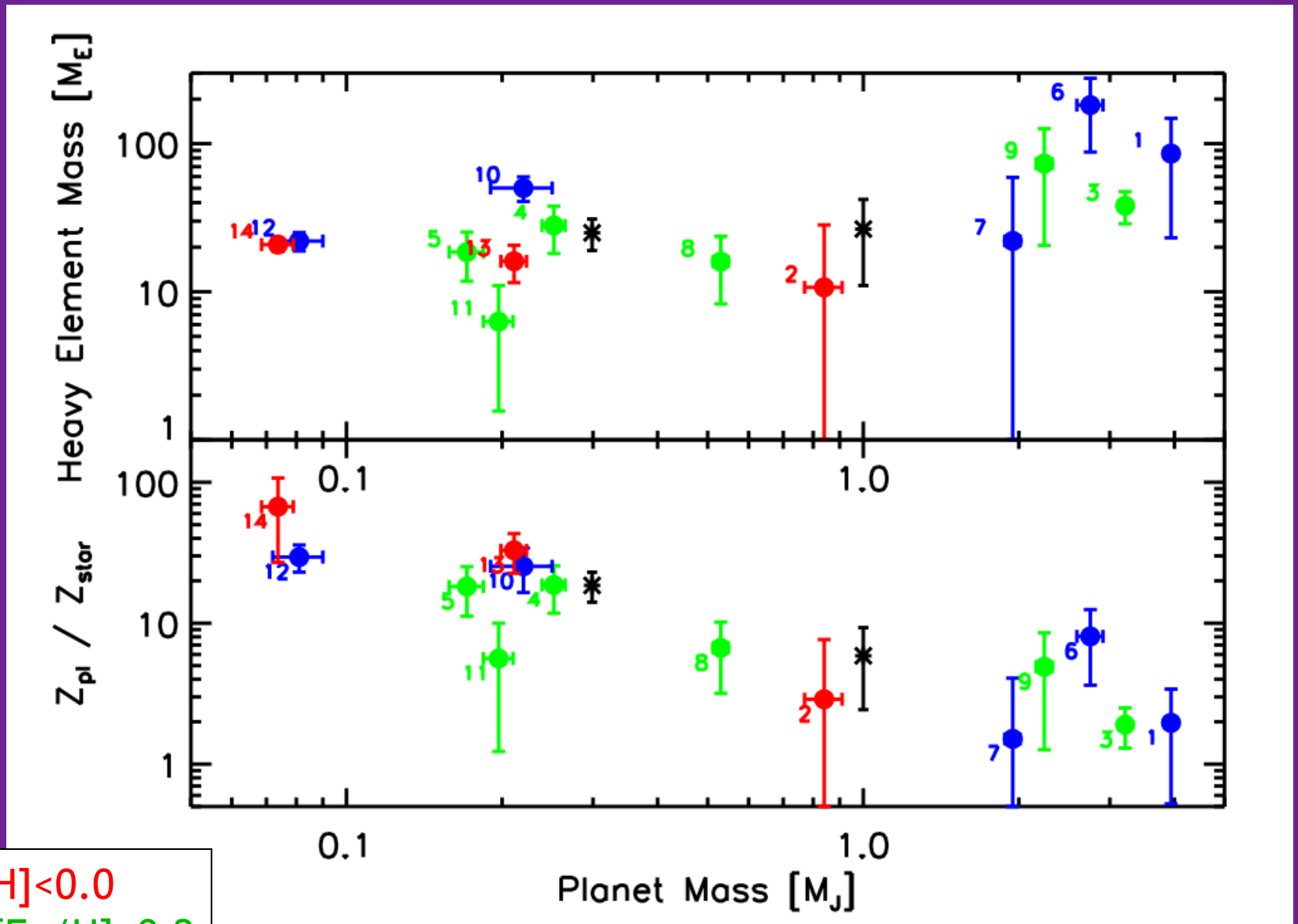


Miller & Fortney (2011), submitted, arXiv:1105.0024

$$\log M_Z = (0.82 \pm 0.08) + (3.40 \pm 0.39)[\mathrm{Fe/H}]$$

See also, Guillot et al. (2006,2008)

Even massive planets appear to be enriched!



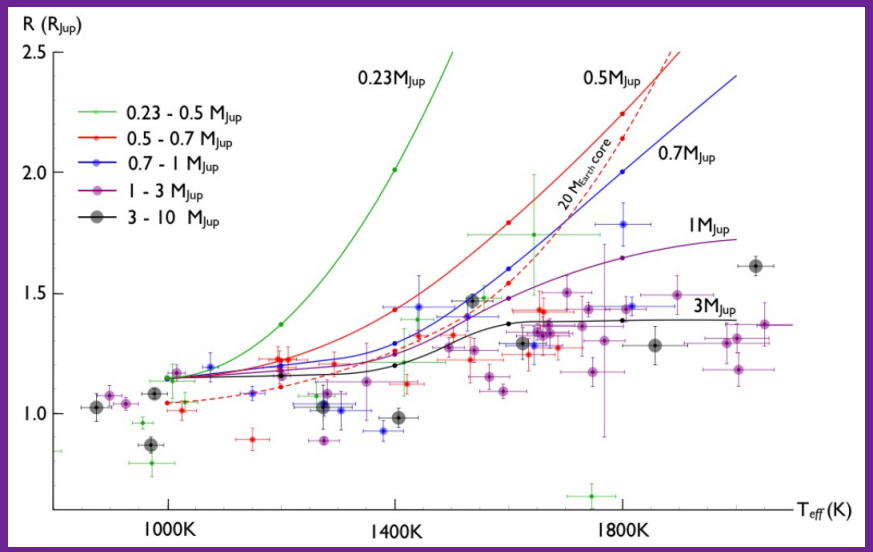
[Fe/H]<0.0
0.0≤[Fe/H]<0.2
0.2≤[Fe/H]<0.4

Miller & Fortney (2011), submitted, arXiv:1105.0024

Conclusions

See the paper: arXiv:1105.0024

- Giant planets, as a class, are enriched in heavy elements
  - Enriched compared to their parent stars
  - Enrichment is a strong inverse function of mass, but with an apparent "floor" at high mass
- The heavy element mass of an *inflated planet* could be estimated only from the planet's mass and stellar metallicity
  - With that in hand, its additional interior power could be constrained
  - Radius inflation mechanism can be studied vs. orbital separation and planet mass



Batygin et al. (2011)

- Massive planets and low-mass brown dwarfs should have structural and atmospheric abundance differences
- The population of low-irradiation planets is expanding rapidly, which will confirm or refute this relation

Thanks for listening!