



OUTREACH



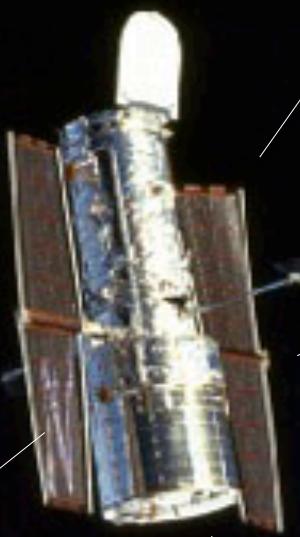
DATA ARCHIVE



SERVICING MISSIONS

HUBBLE SPACE TELESCOPE: Piecing Together the Workings of the Universe

Robert Williams
STScI



SPACE



S P H E R I C A L
A B E R R A T I O N

First photos from the Hubble



The moon.



Jupiter

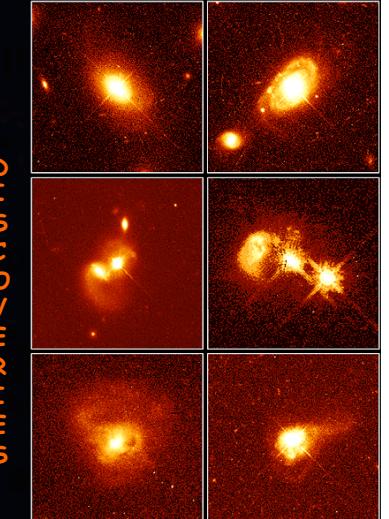
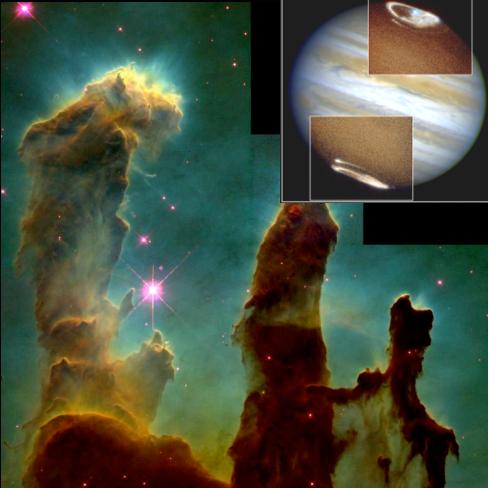


Saturn



Taxpayers

A T T R A C T I V E
I M A G E S

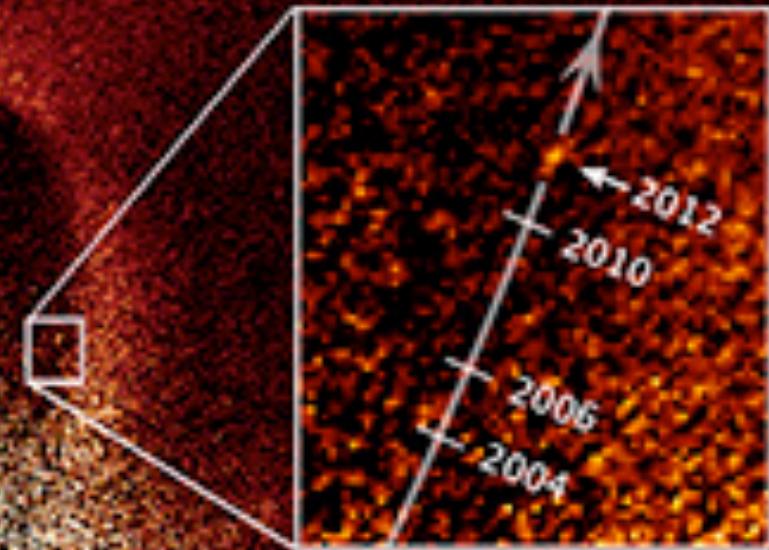


D I S C O V E R I E S
M A J O R

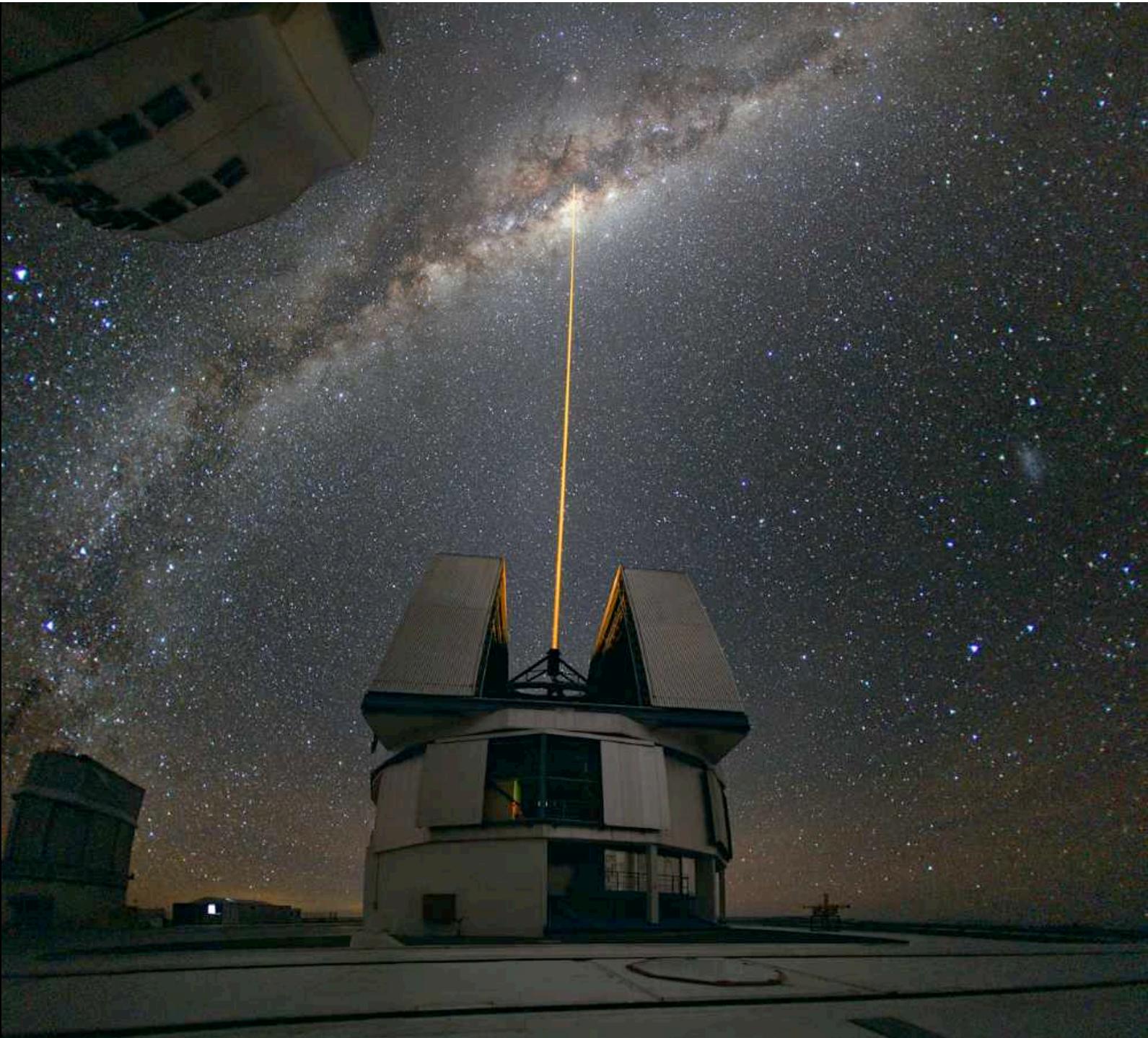
Reprinted by permission of NEA, Inc.

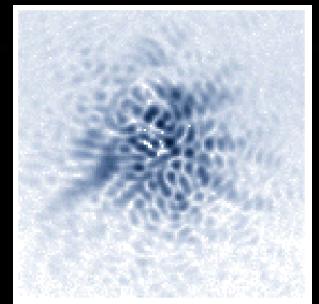
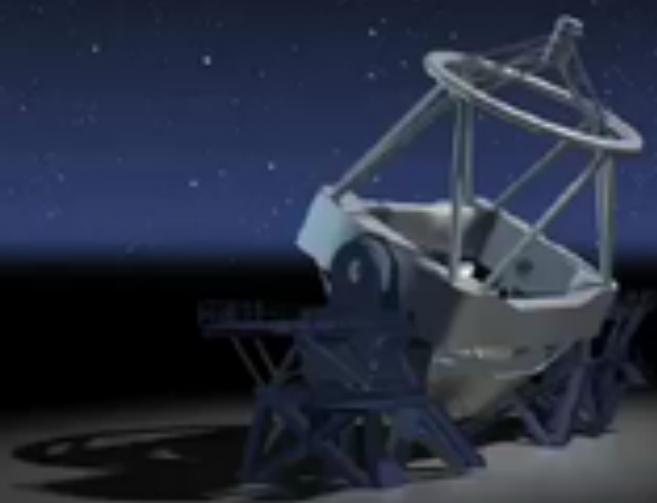
Markie©1999

Fomalhaut



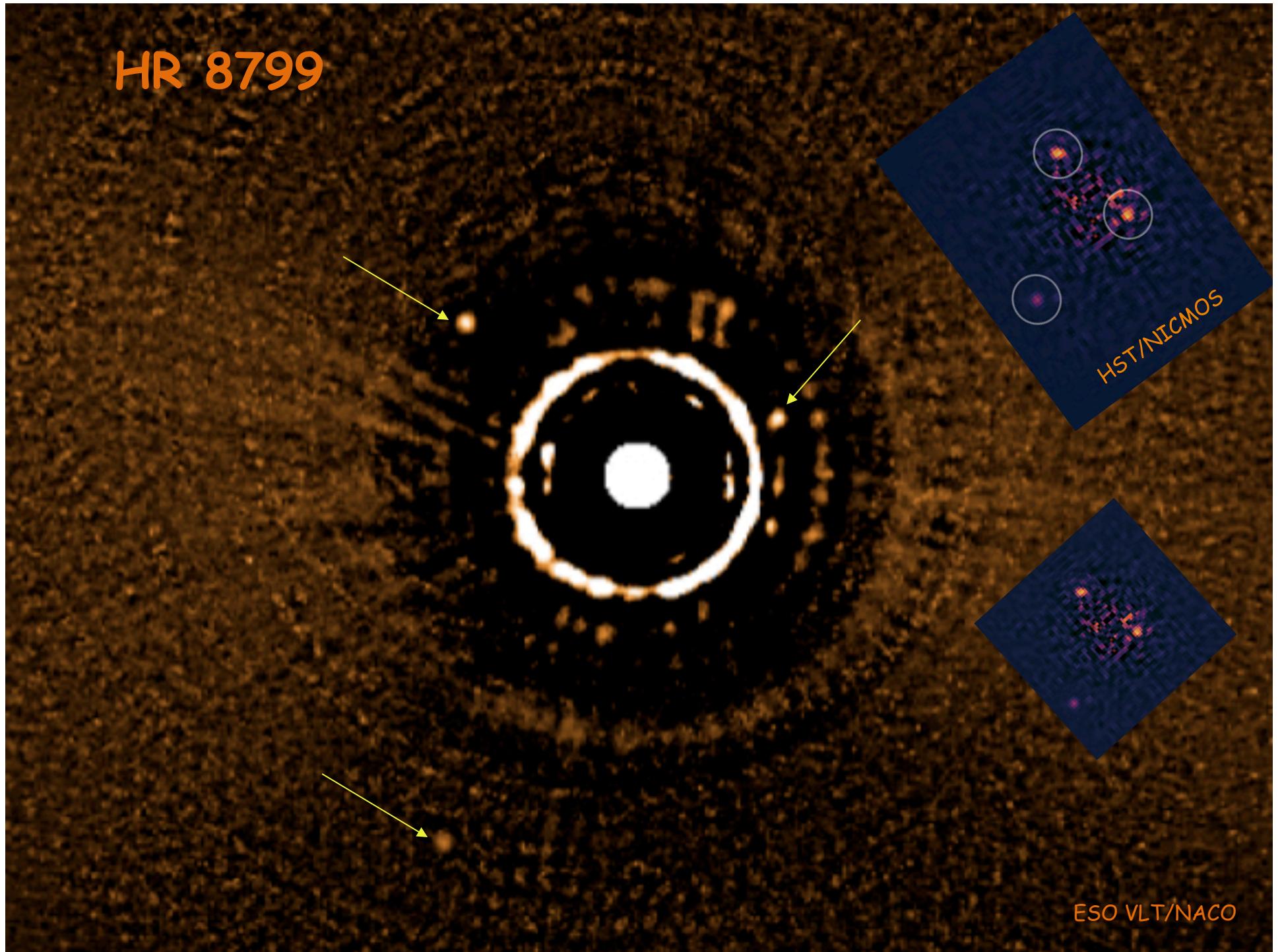
HST/STIS
Kalas, 2012





ESO

HR 8799



ESO VLT/NACO

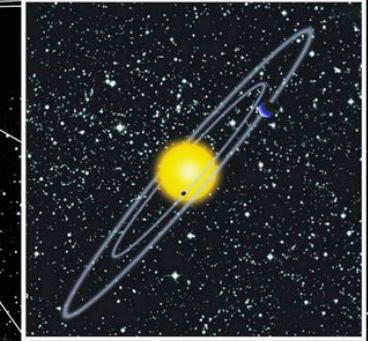
National Aeronautics and Space Administration

Kepler

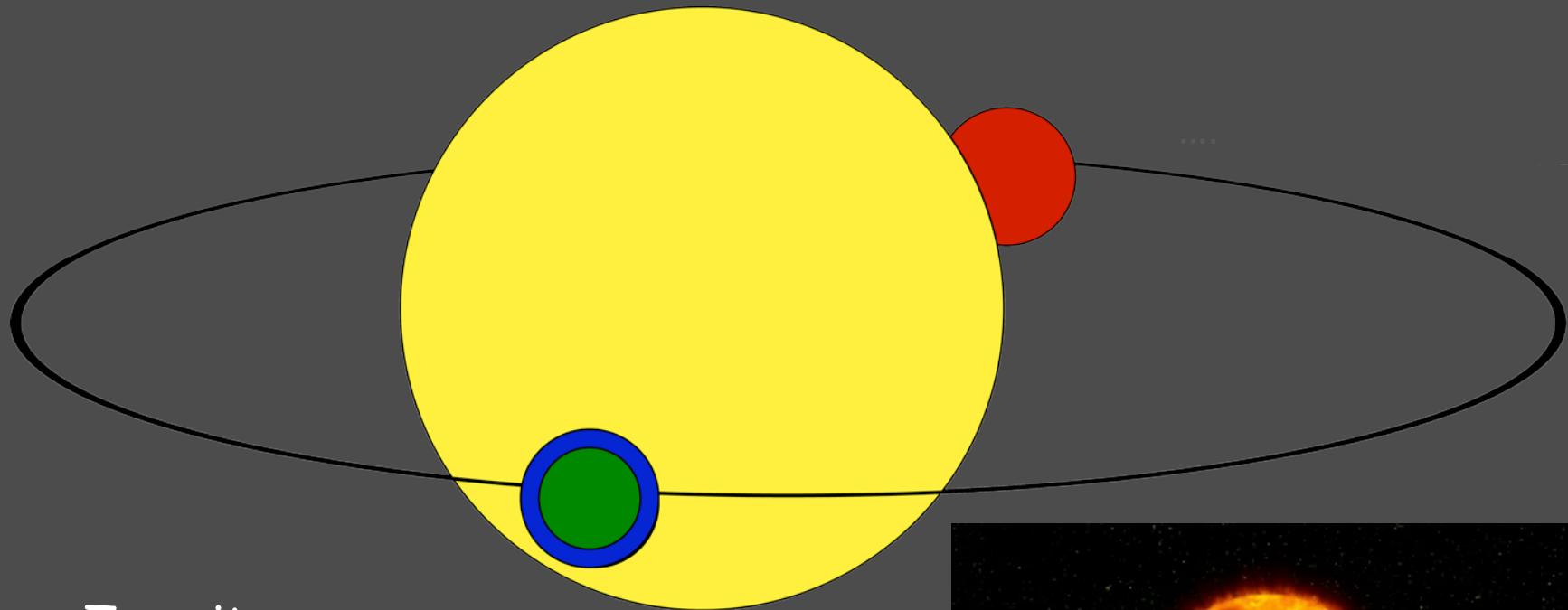
NASA's First Mission Capable of
Finding Earth-size & Smaller Planets

Vega

Deneb

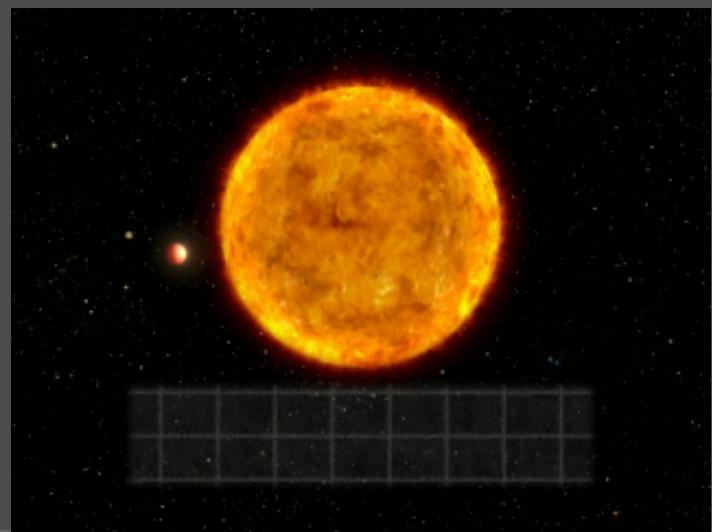


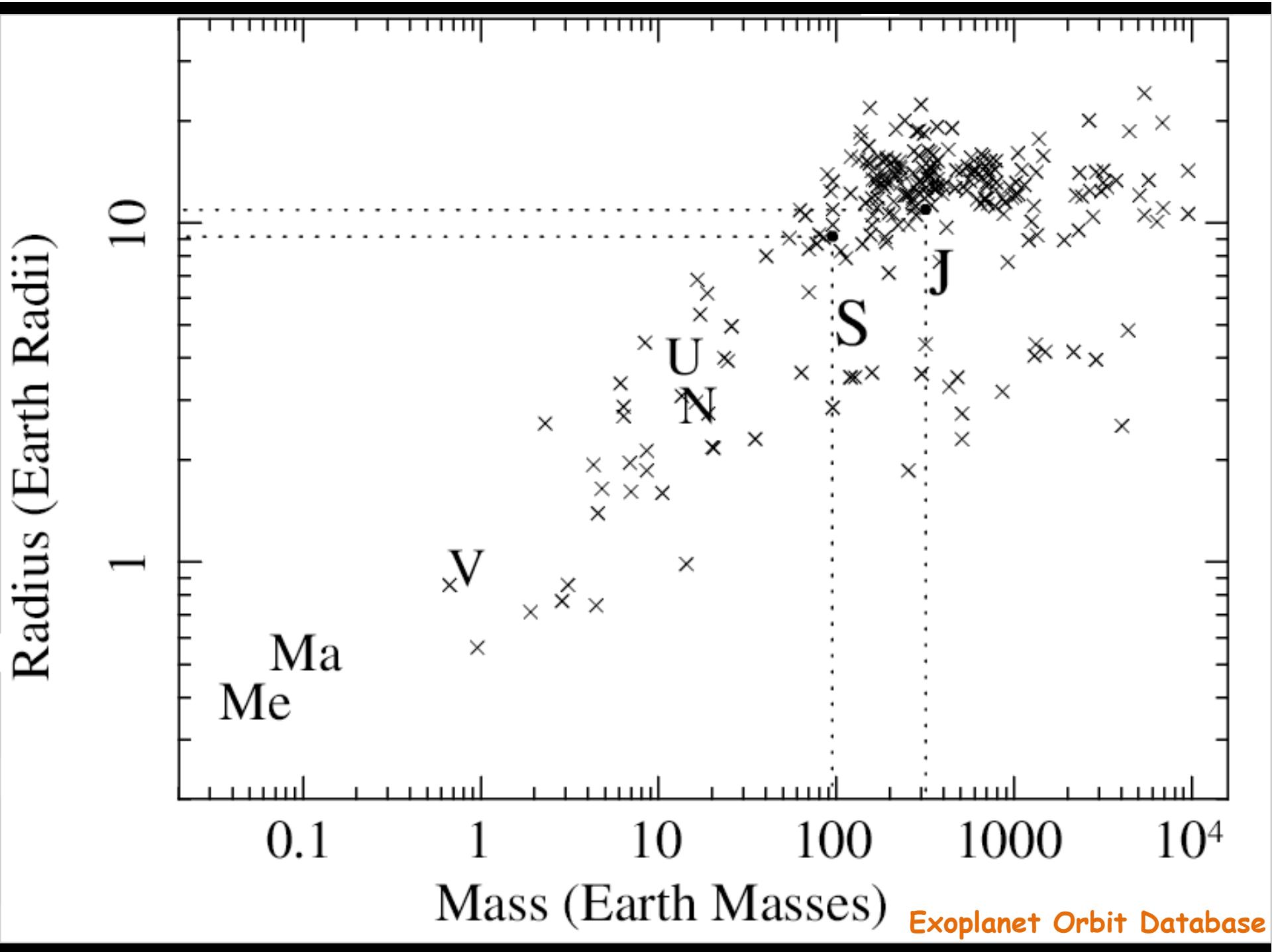
Exoplanet Transit and Eclipse

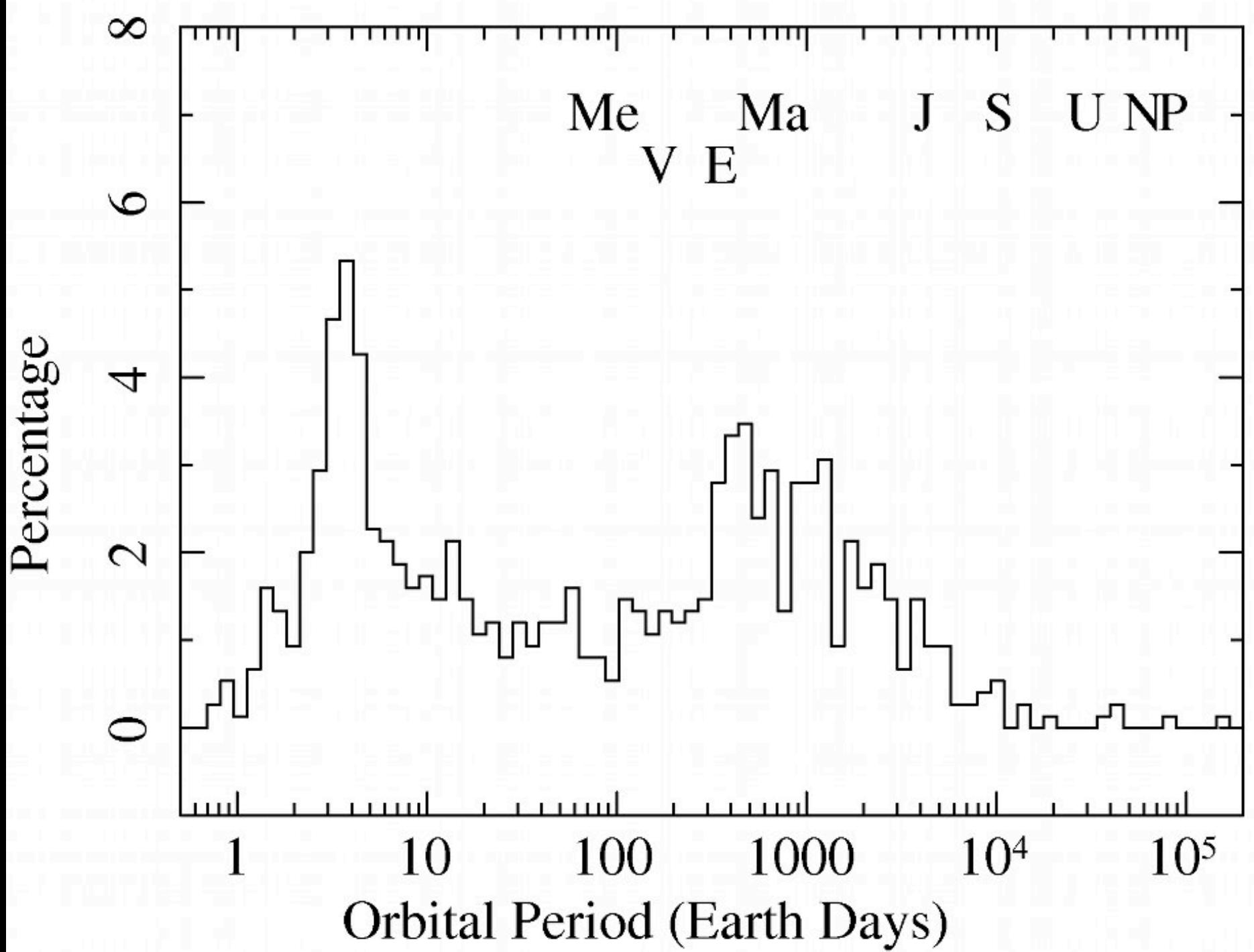


Transit

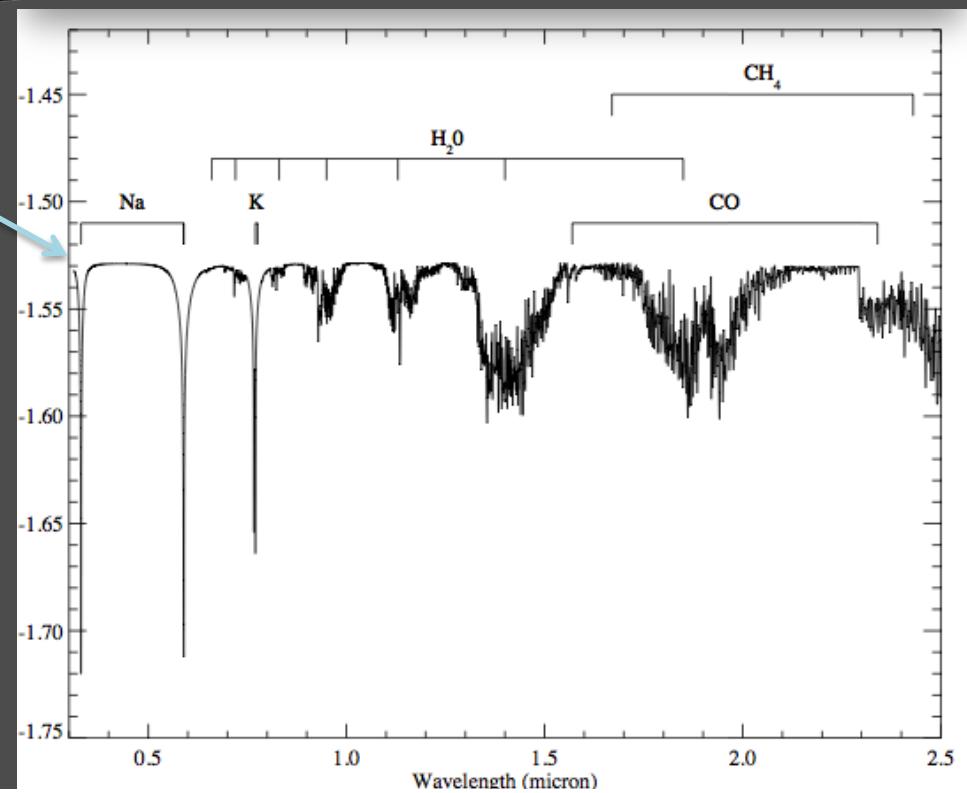
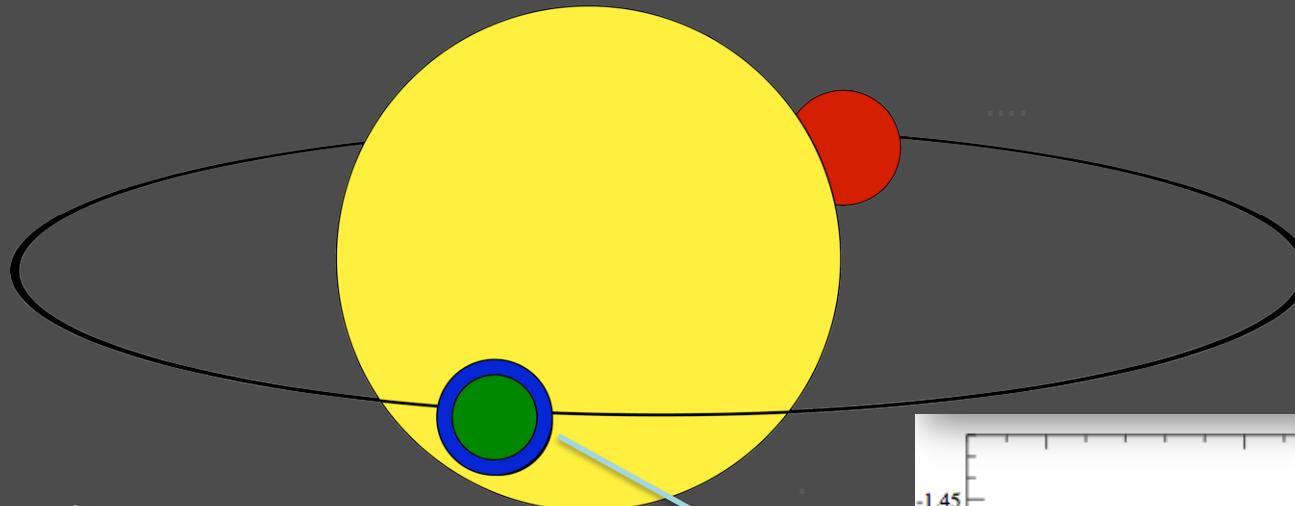
Relative obscuration by planet $\sim 10^{-3}$



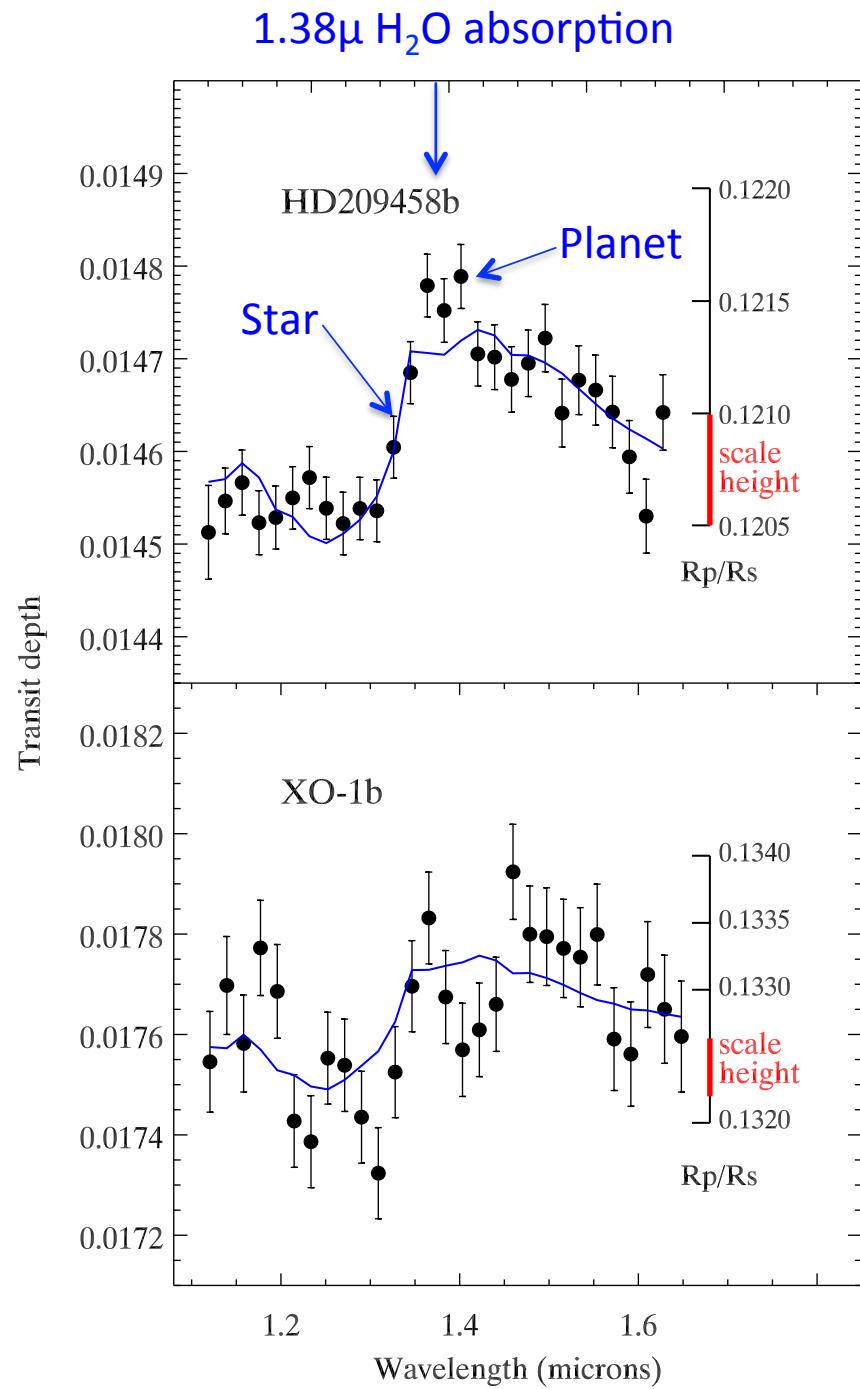
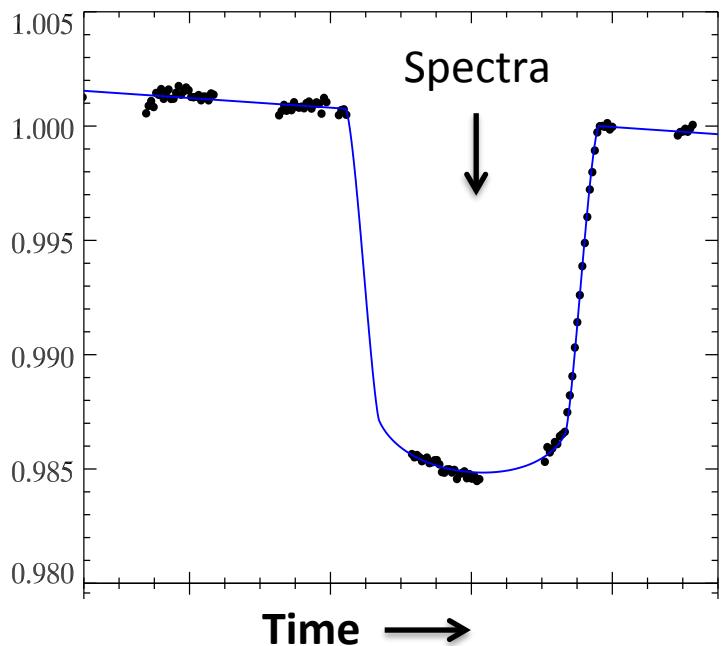




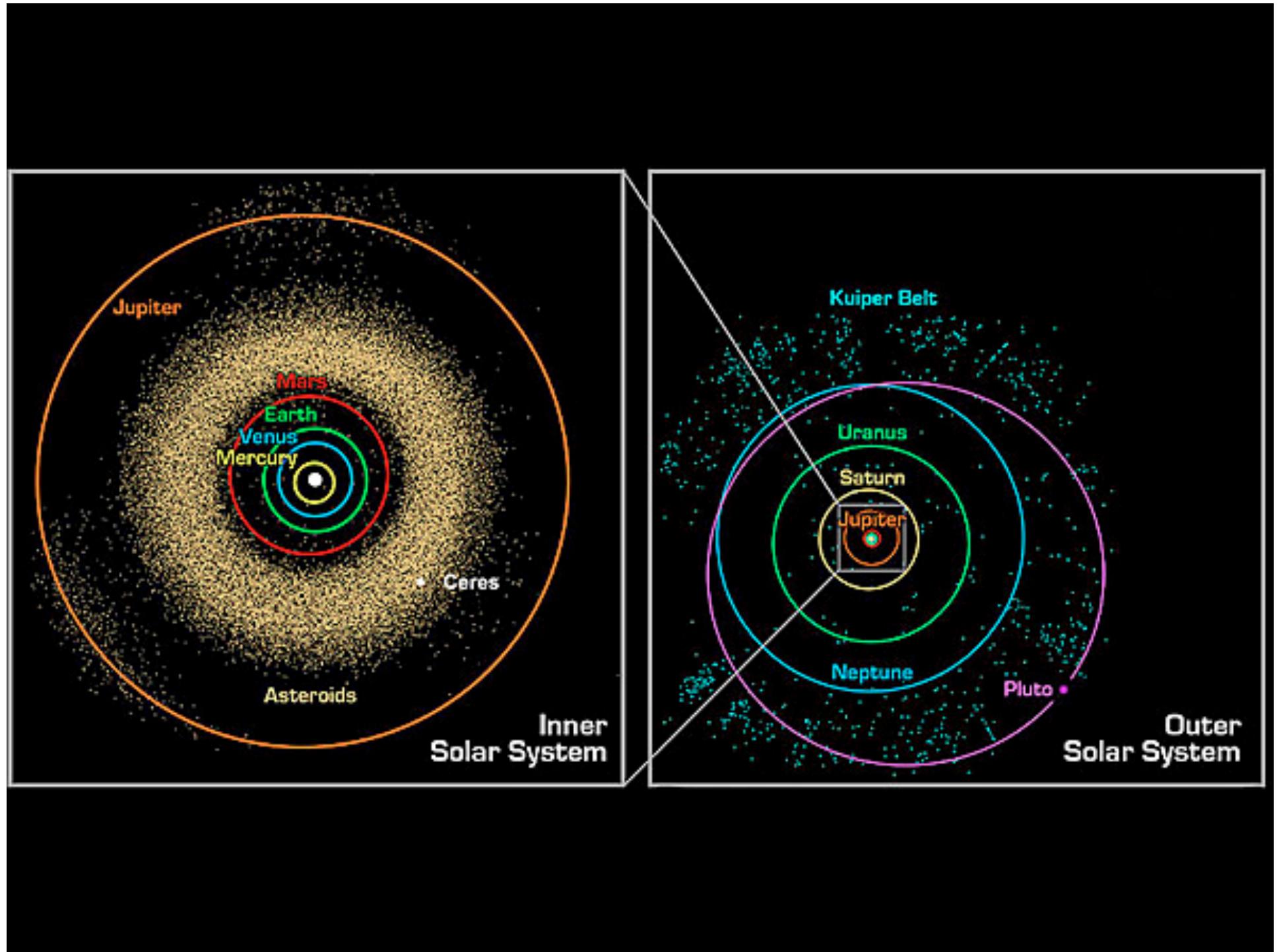
Exoplanet Transit and Eclipse

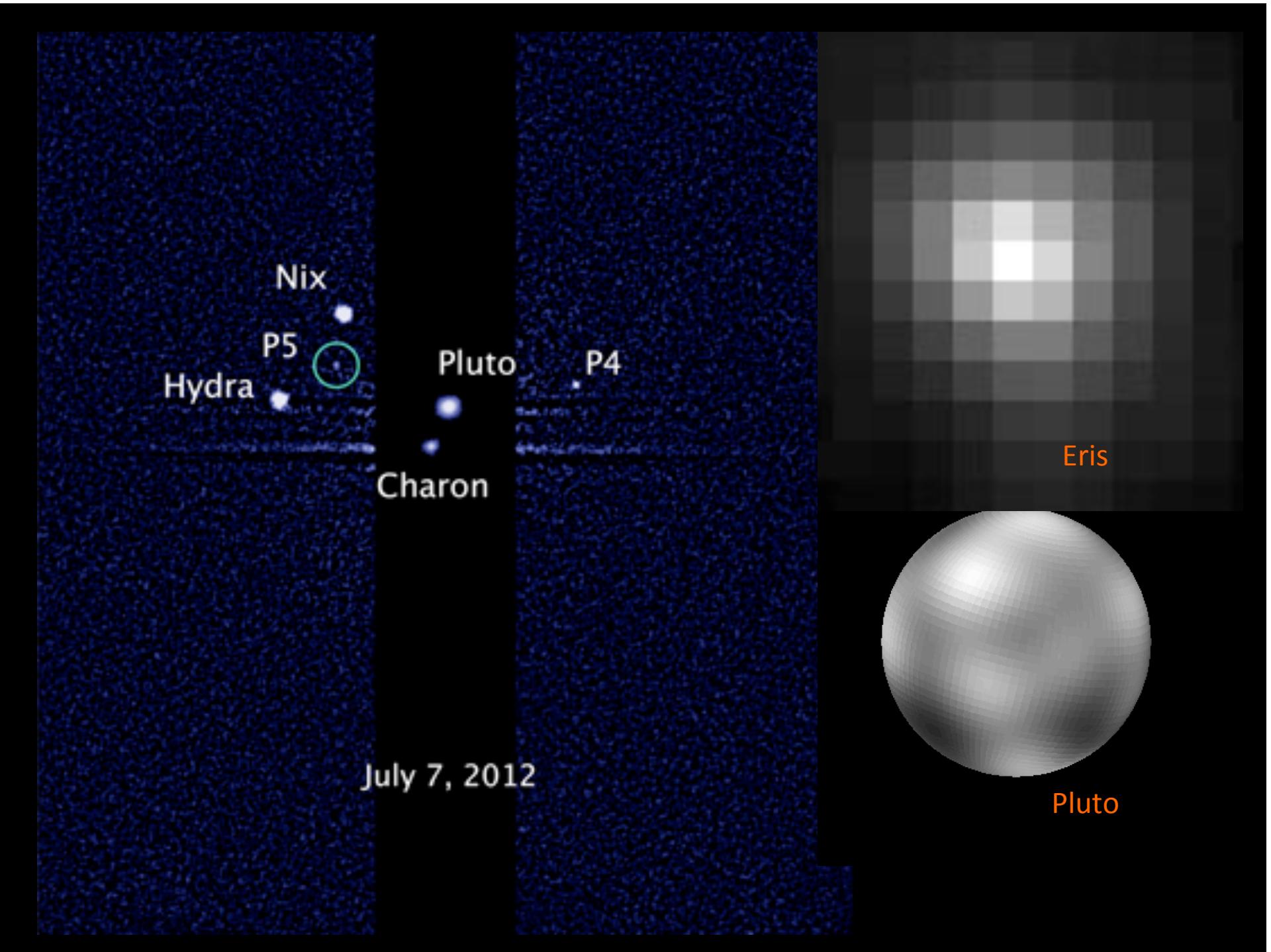


Possible Detection of Water in Exoplanets (Hot Jupiters)

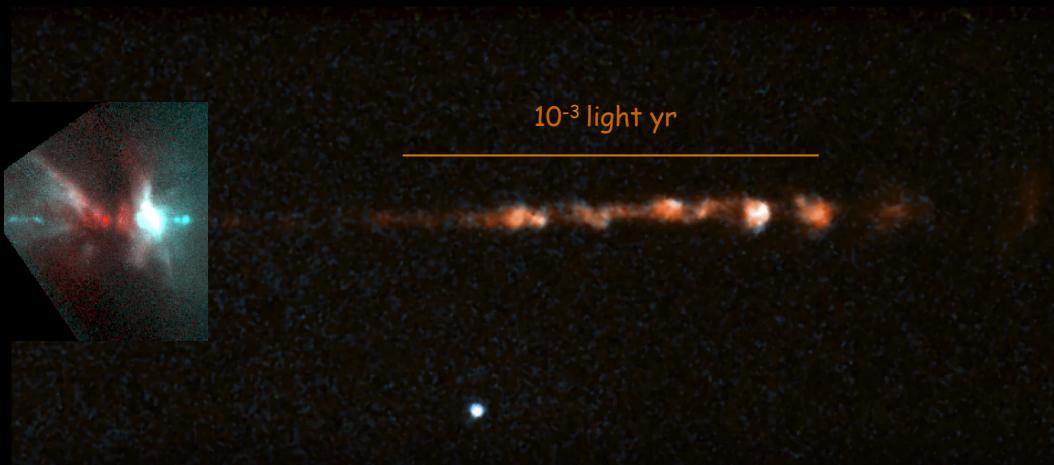


Deming et al. 2013, arXiv1302.1141

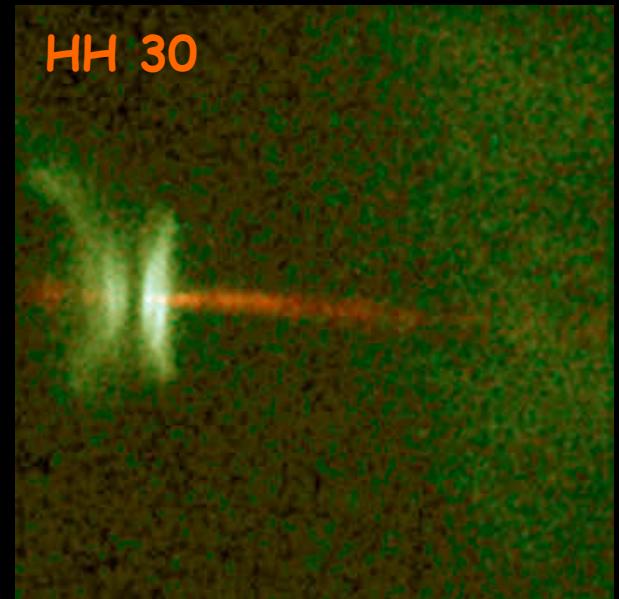




HH 34

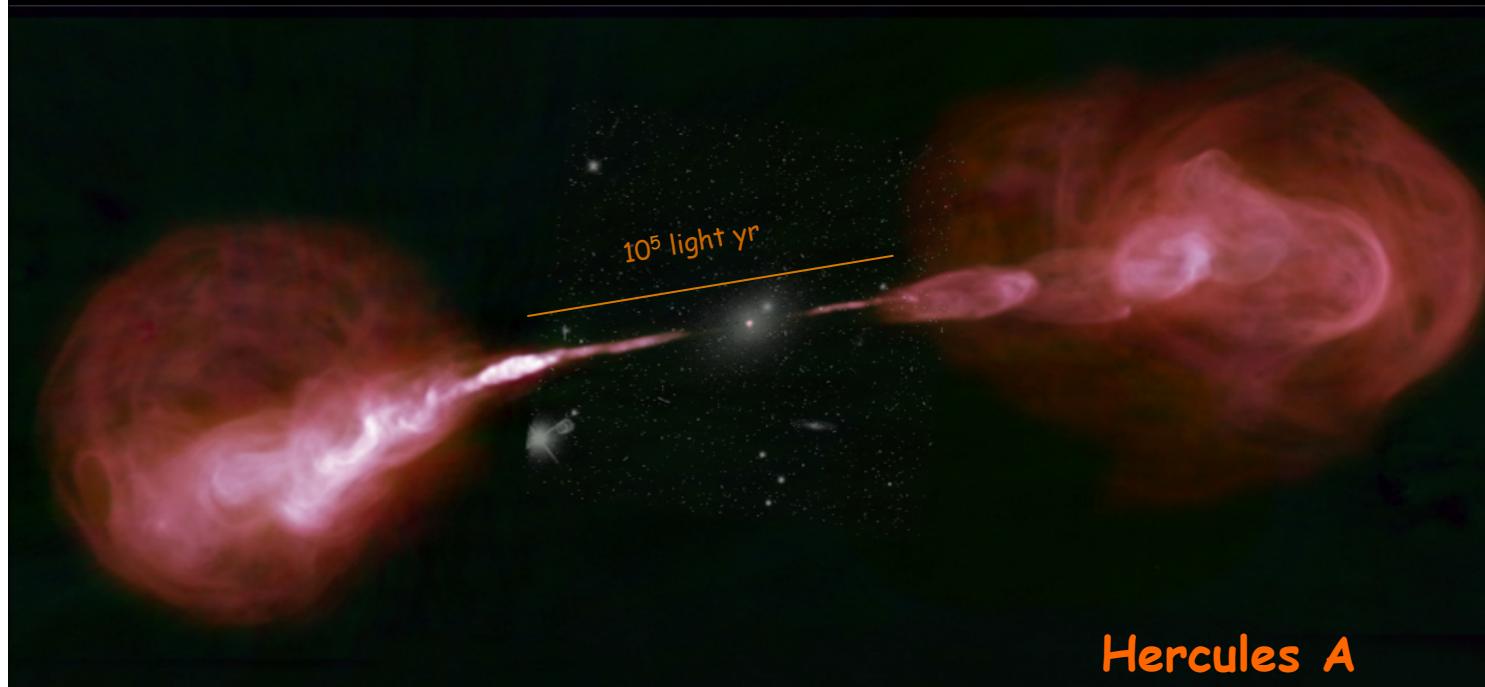


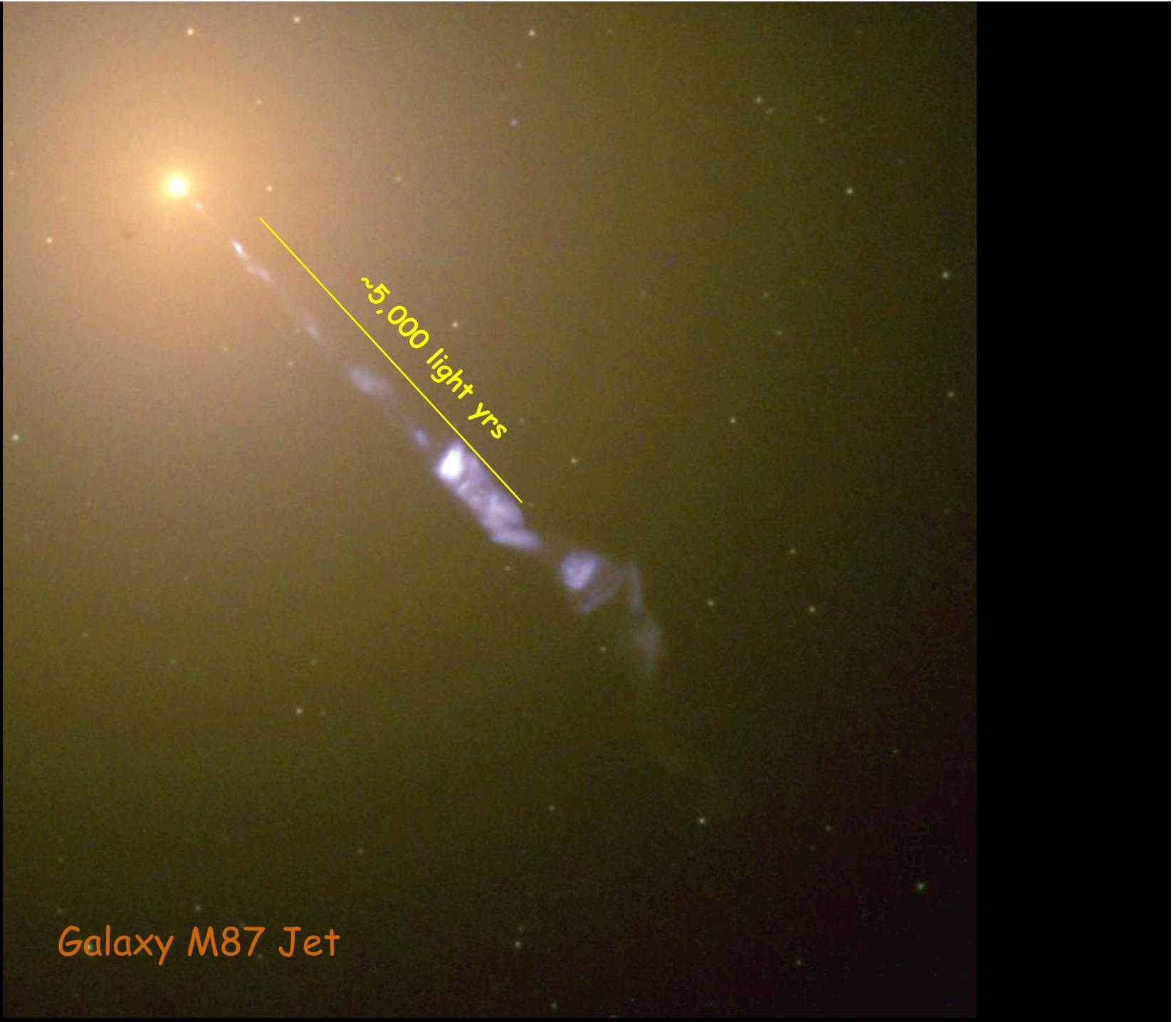
HH 30



10^5 light yr

Hercules A

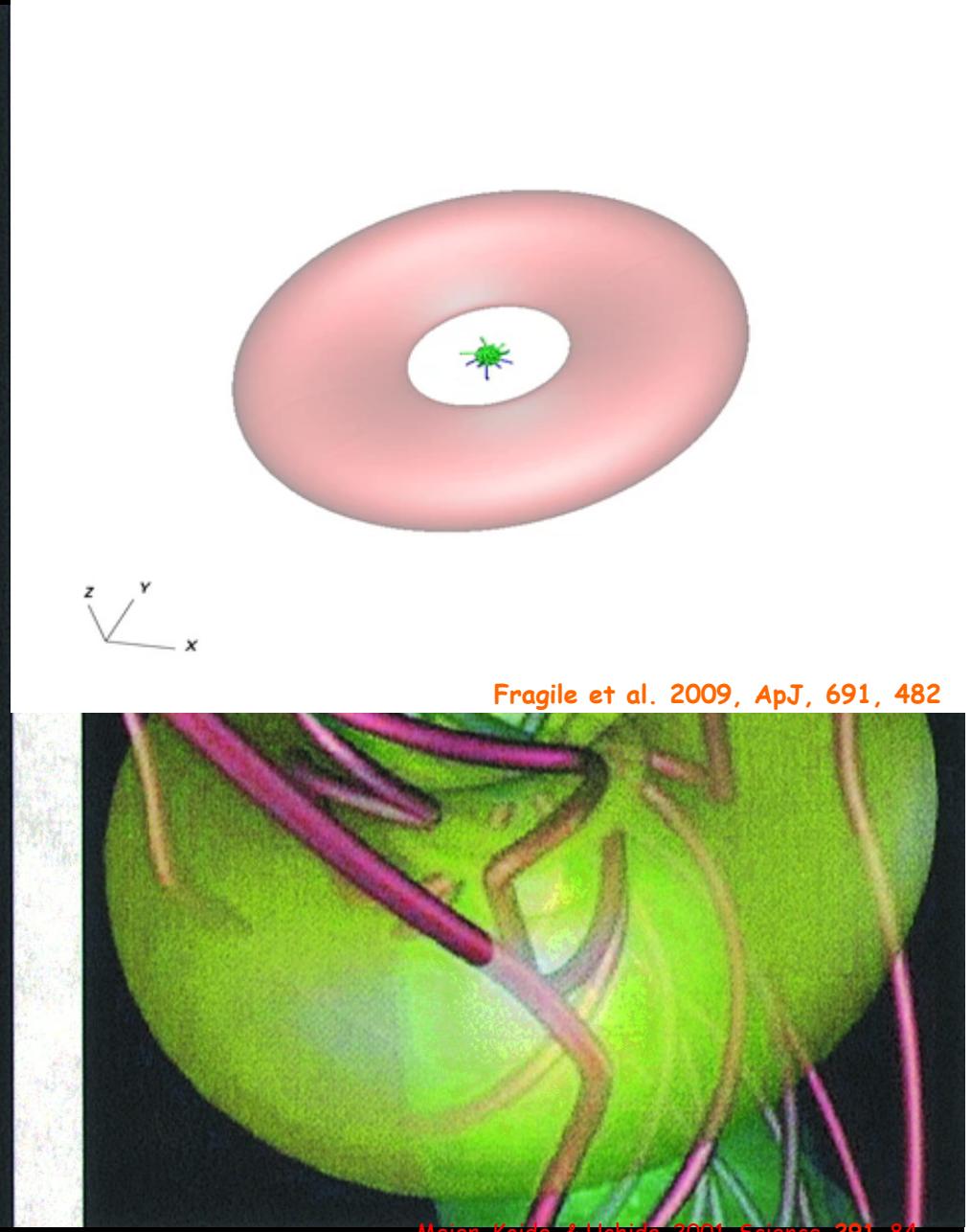
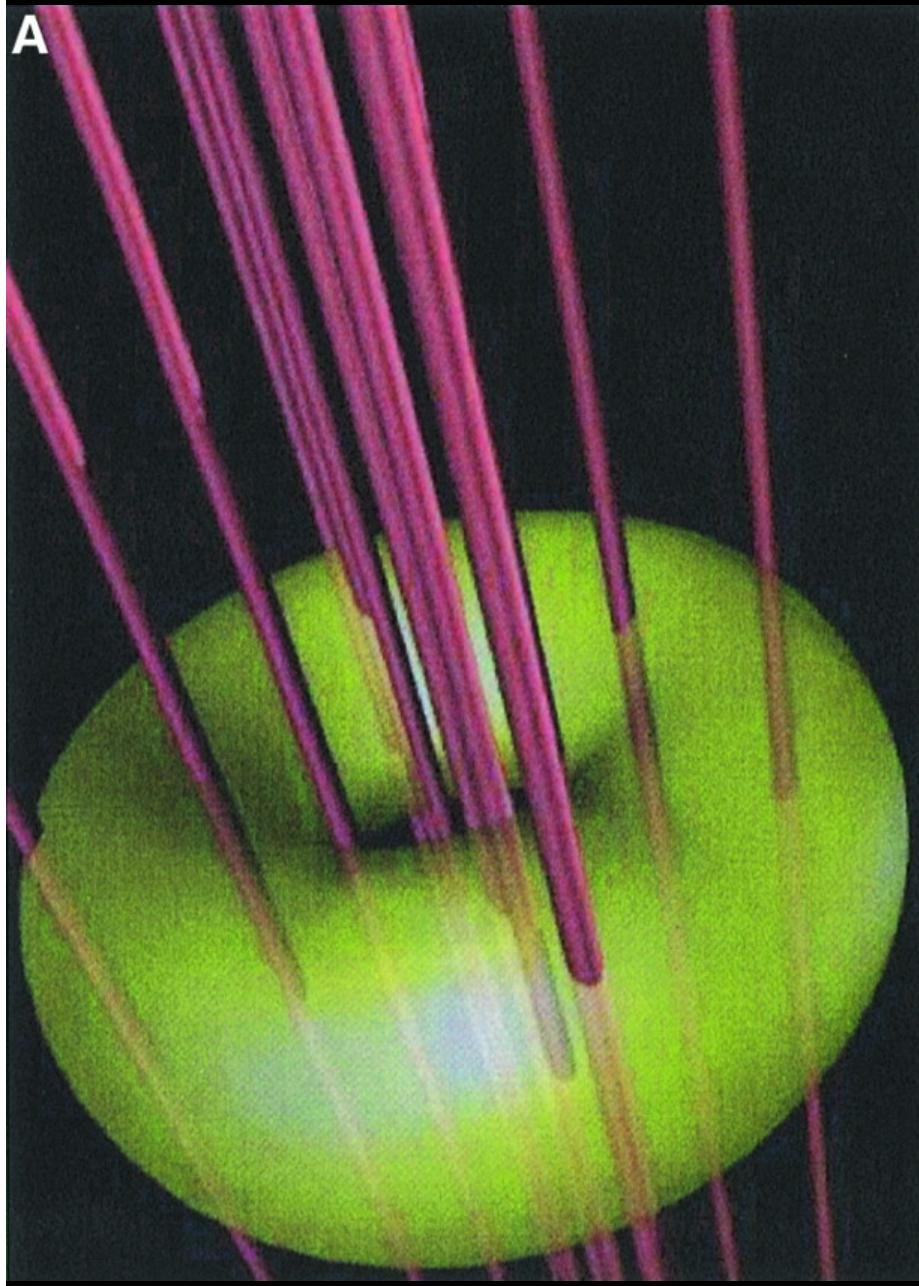




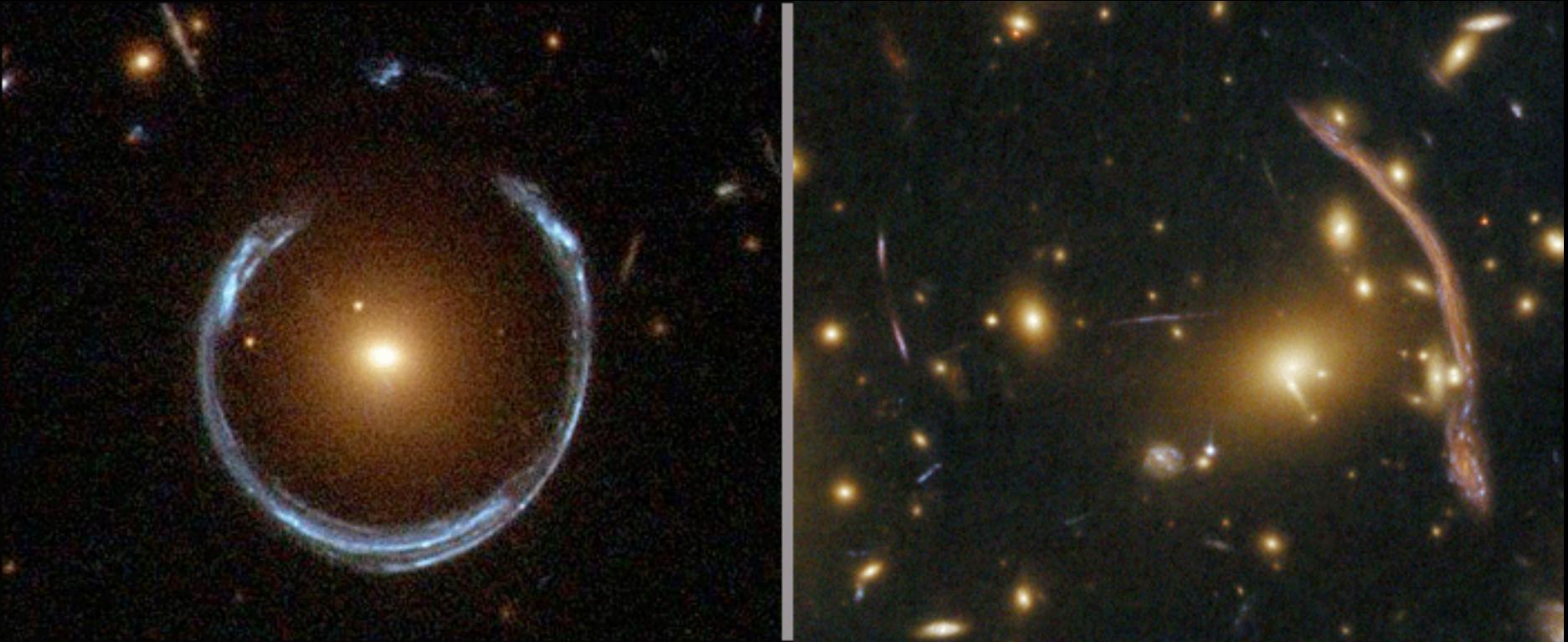
Galaxy M87 Jet

Accretion Disk with 'Magnetorotational Instability'

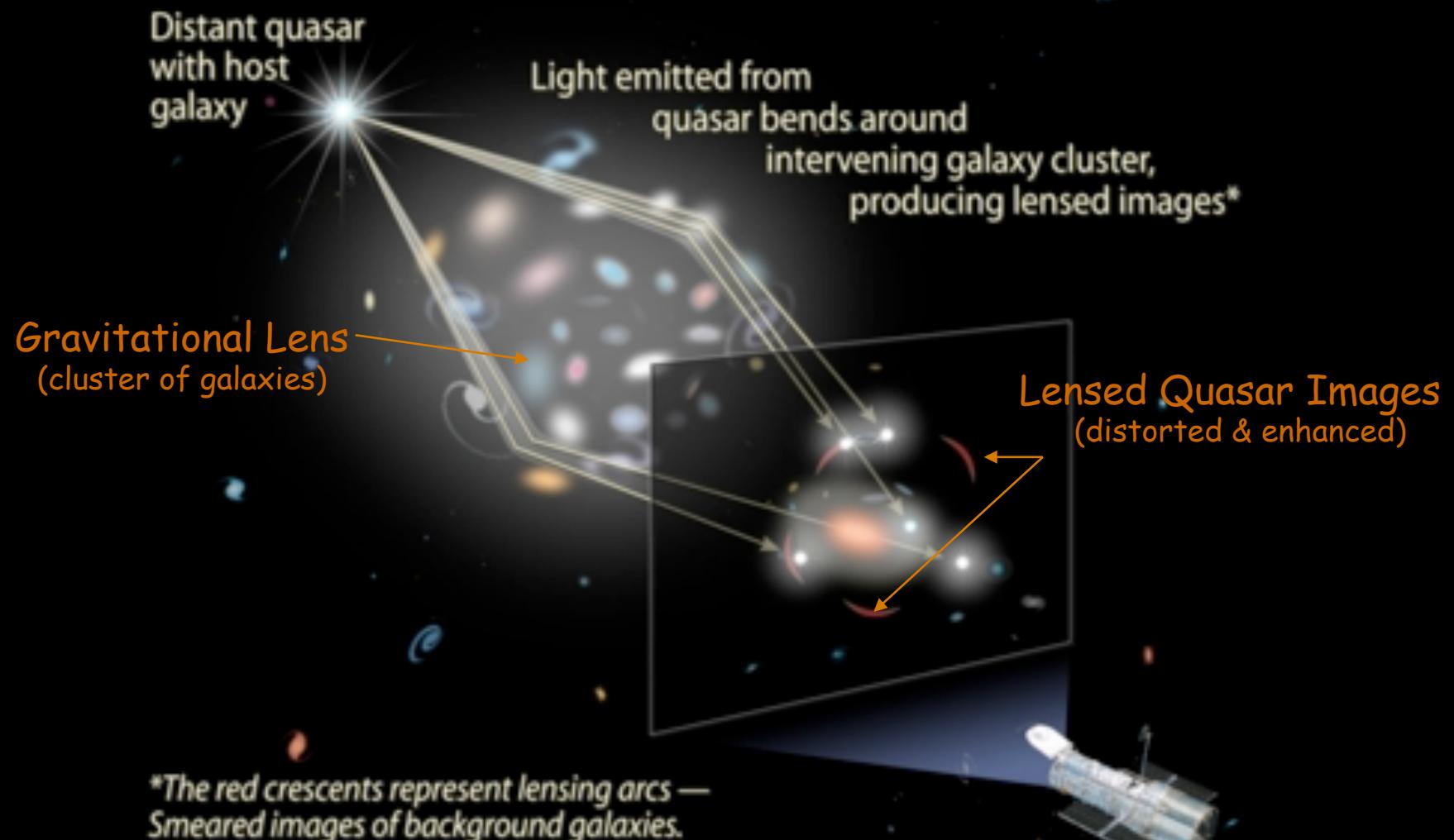
(Balbus, S. & Hawley, J. 1991, ApJ, 376, 214)



Gravitational Lensing & Dark Matter

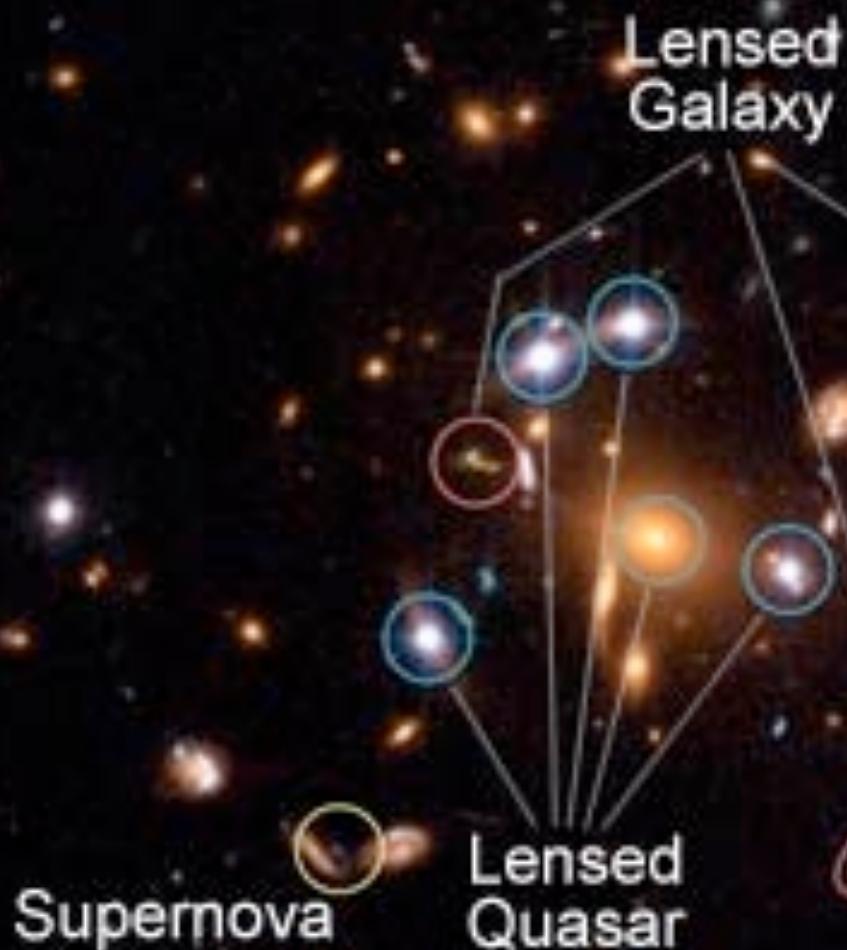


Gravitational Lensing Splits Quasar Light into Five Images

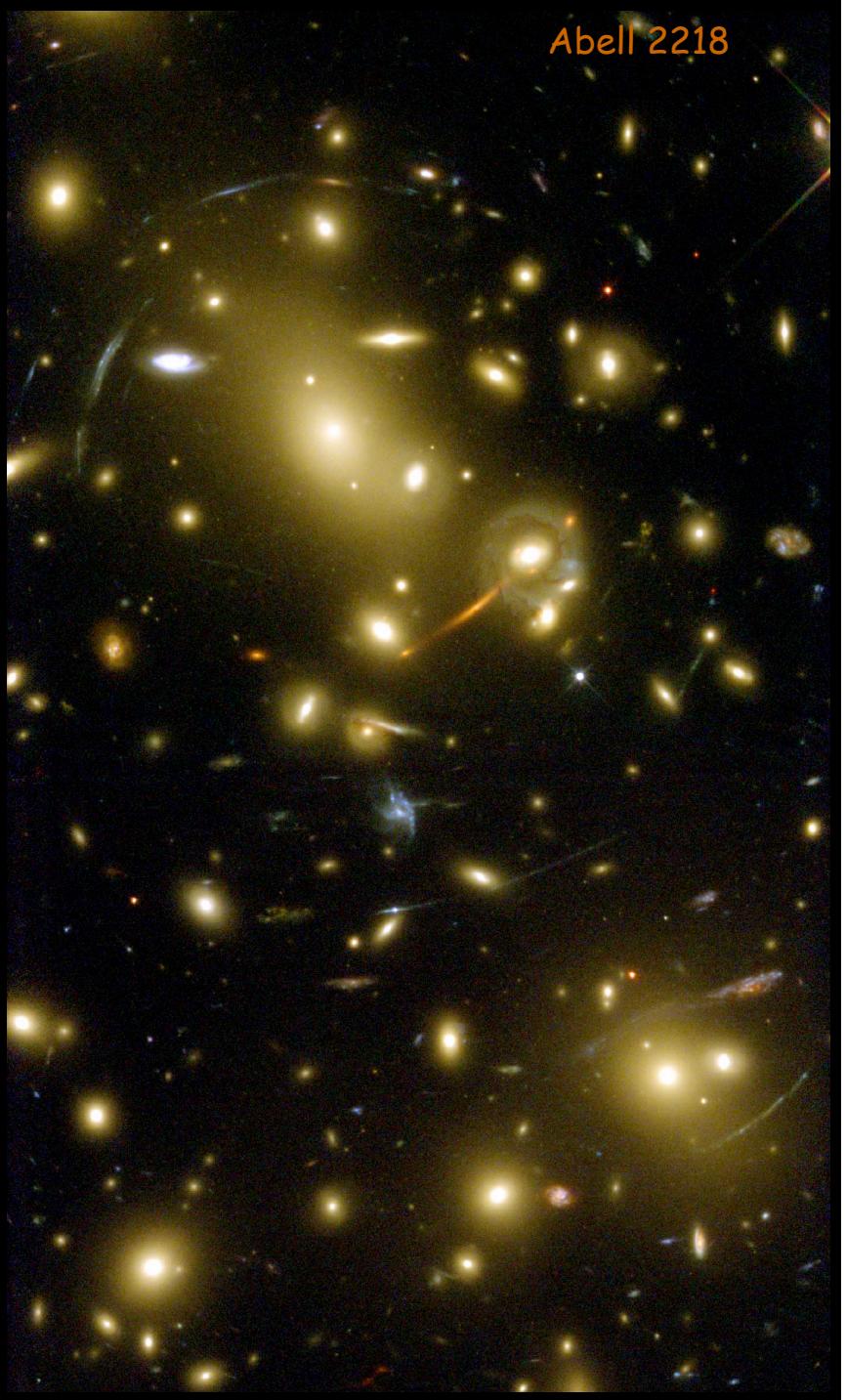


Galaxy Cluster SDSS J1004+4112

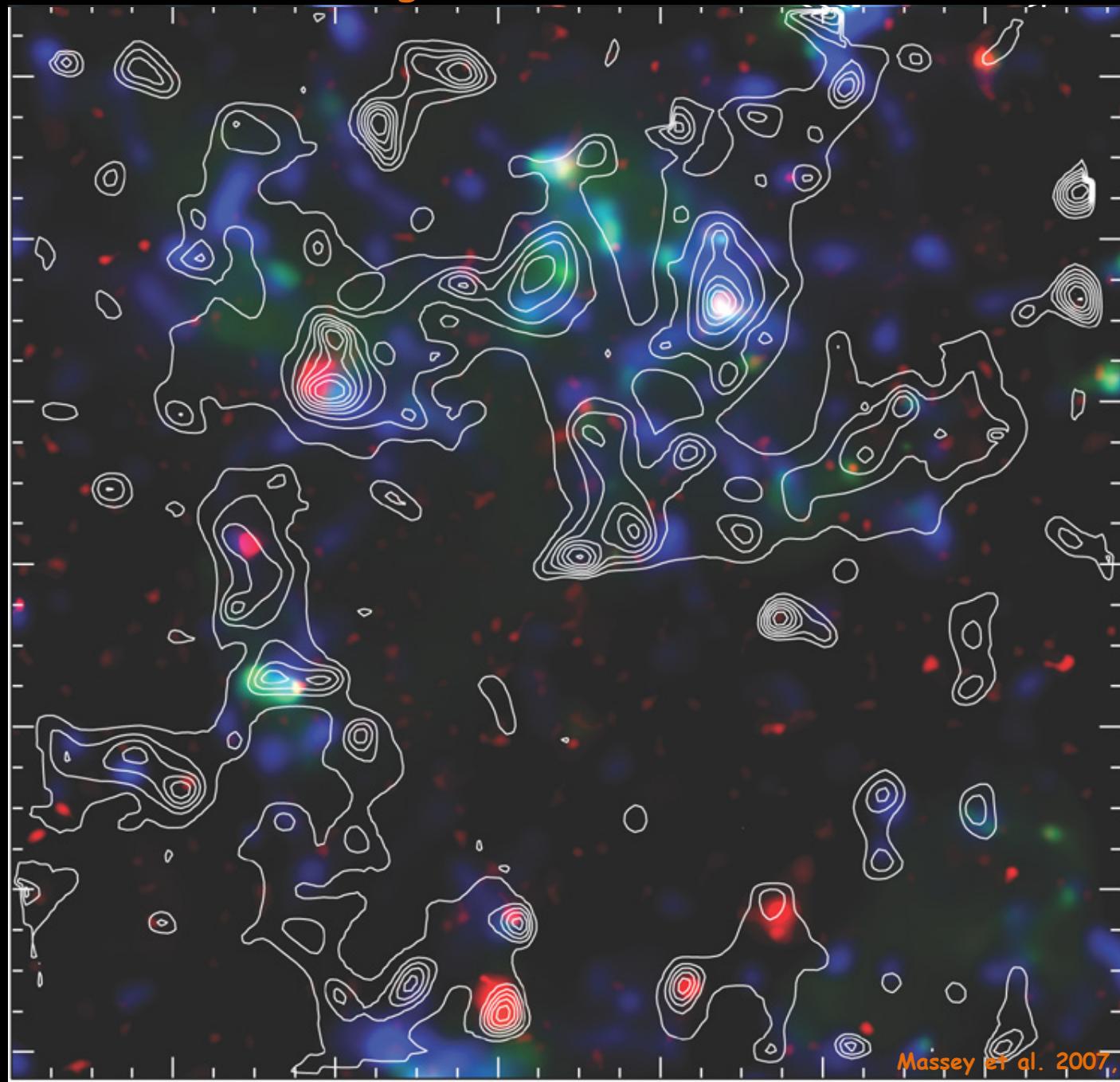
HST ACS/WFC



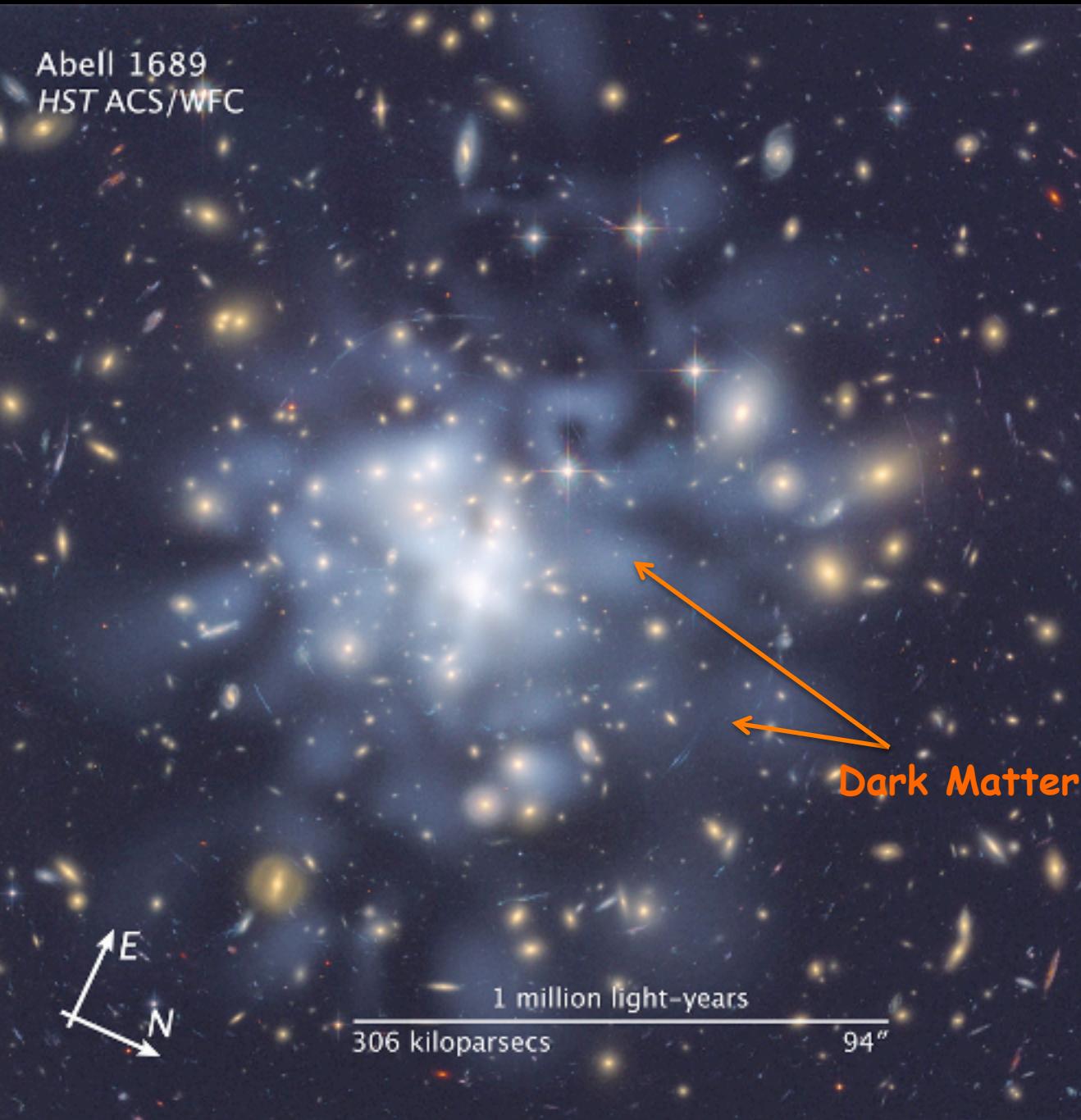
10''



2-Degree COSMOS Field



Massey et al. 2007, Nature, 445, 286

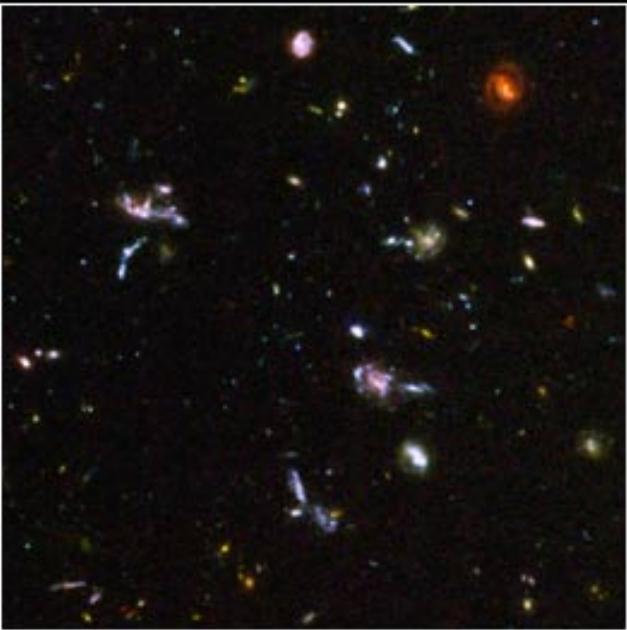
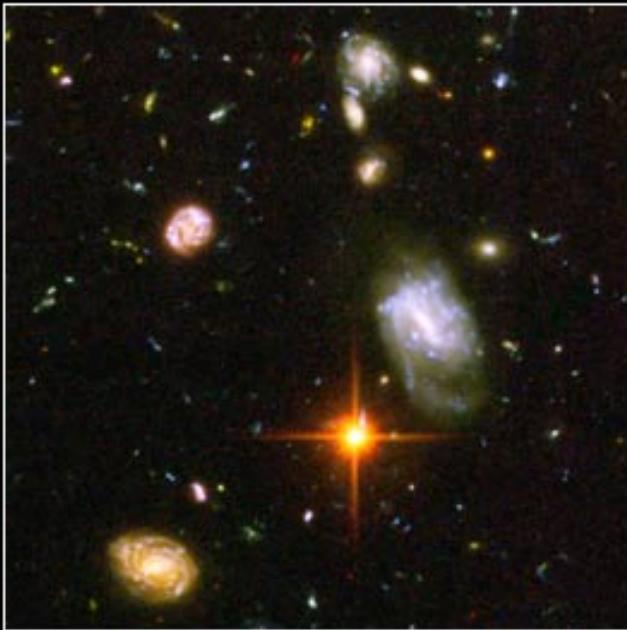
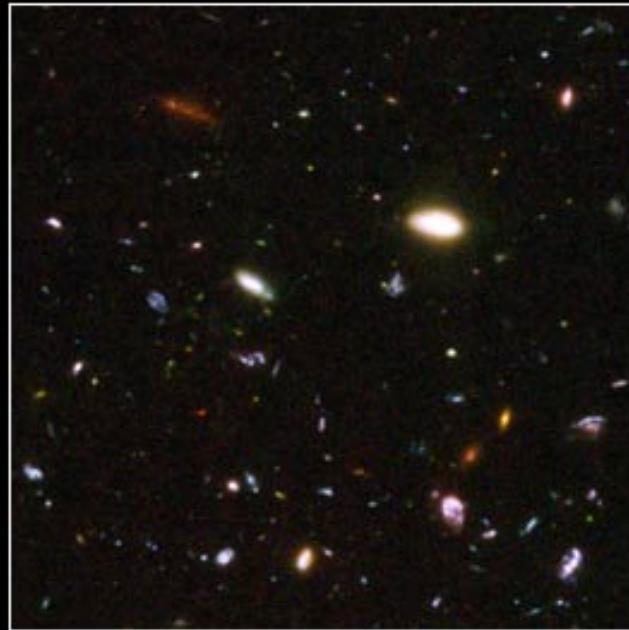
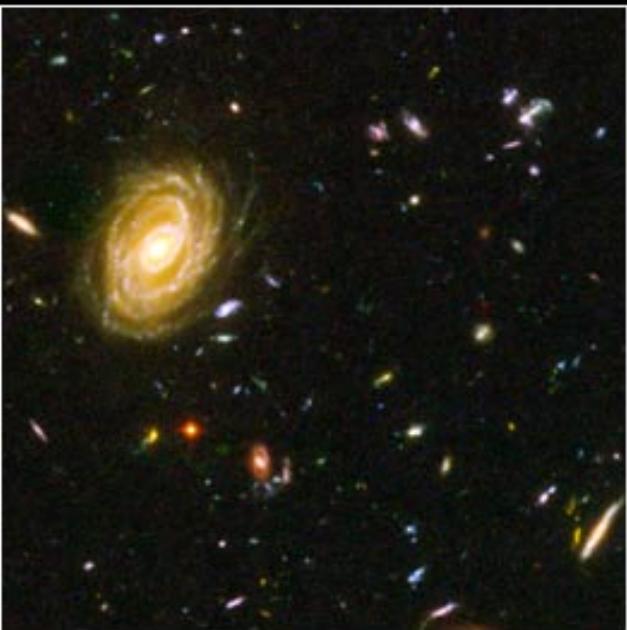
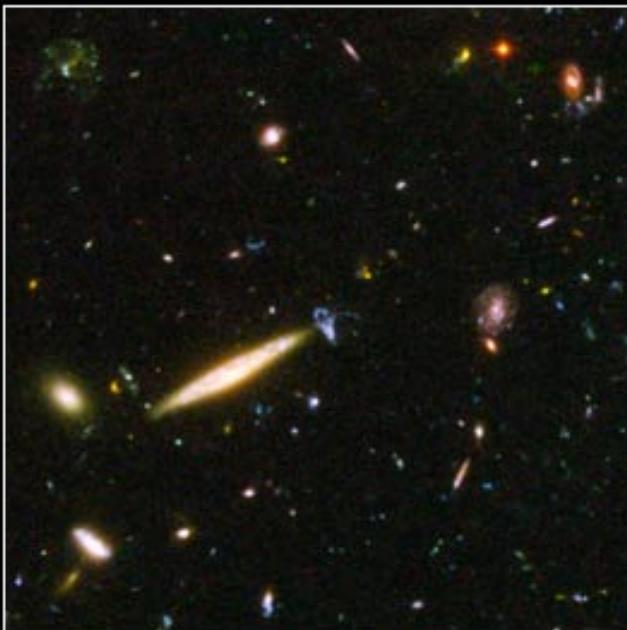


Hubble 'Ultra' Deep Field



Hubble Ultra Deep Field Details

HST • ACS

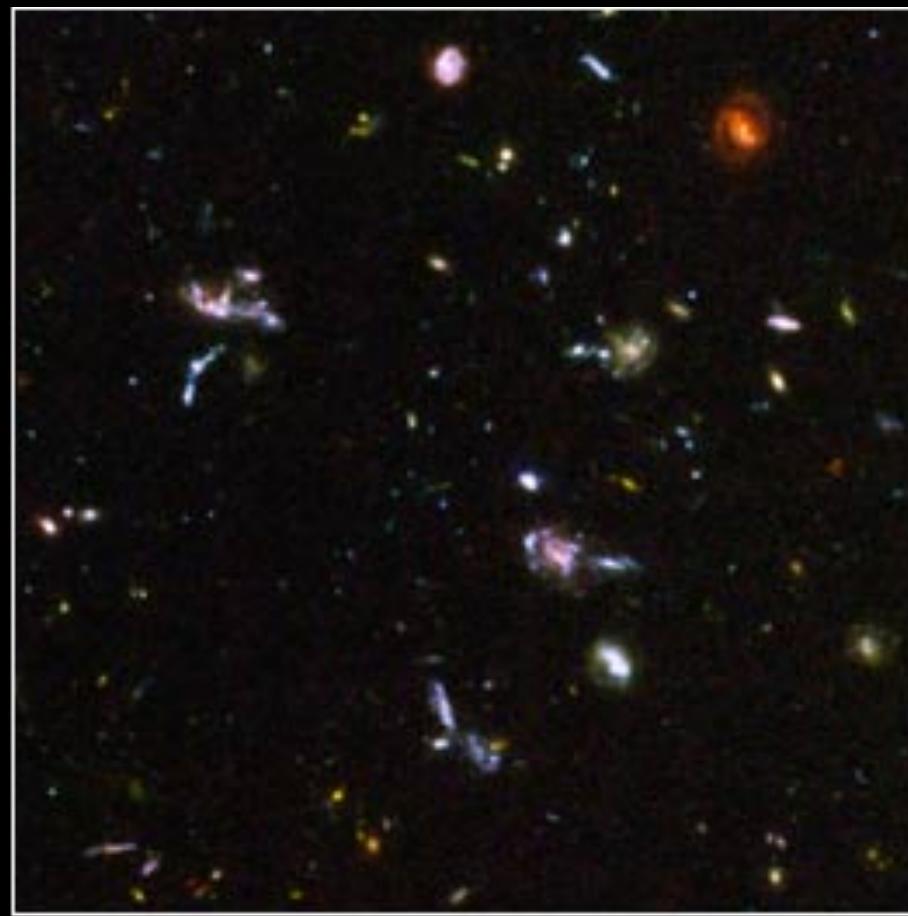


S. Beckwith+HUDF Team

Nearby Galaxies (Present epoch)



Distant Galaxies (11 Gyr ago)



Hubble Deep Field Redshifts

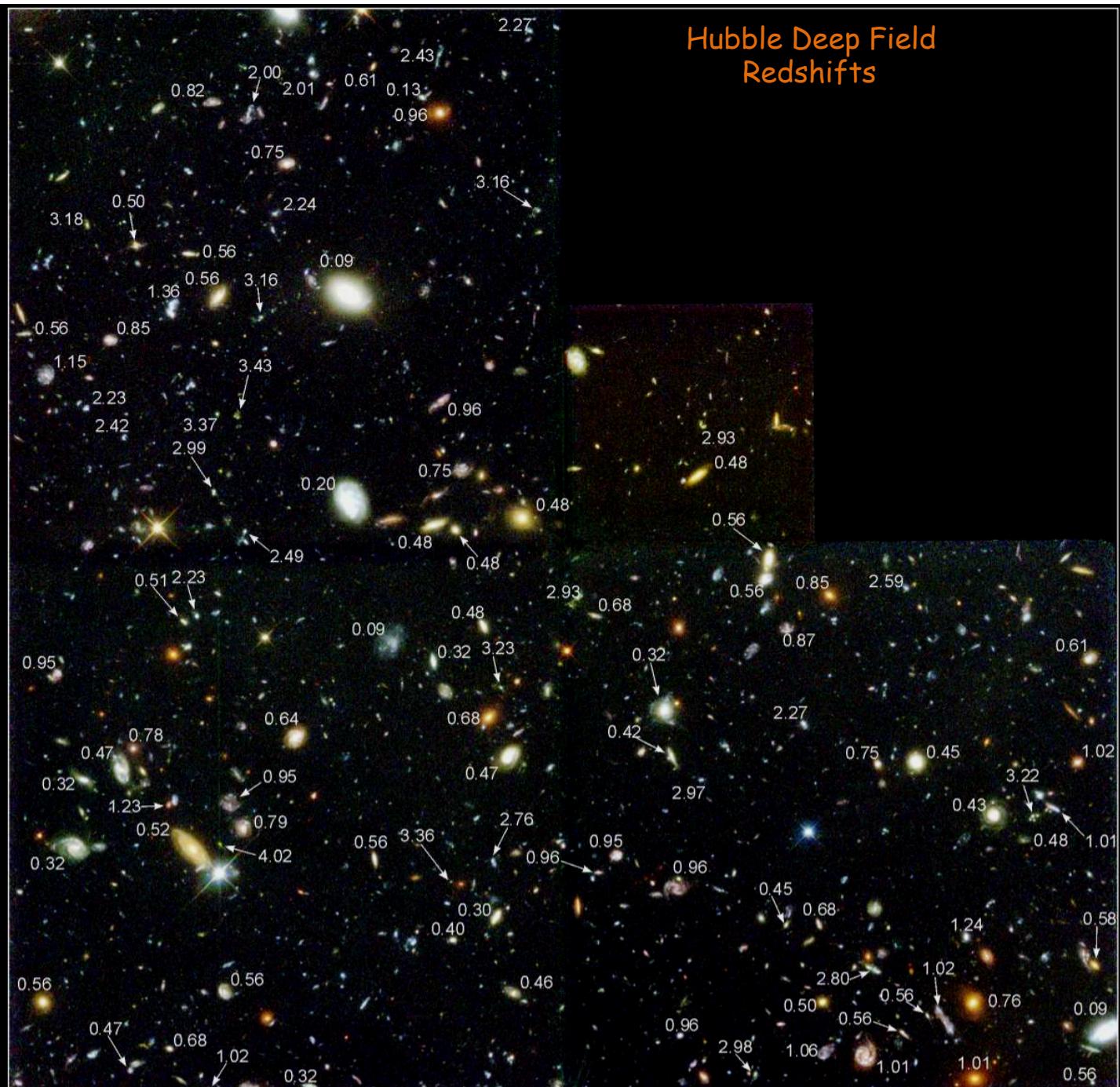
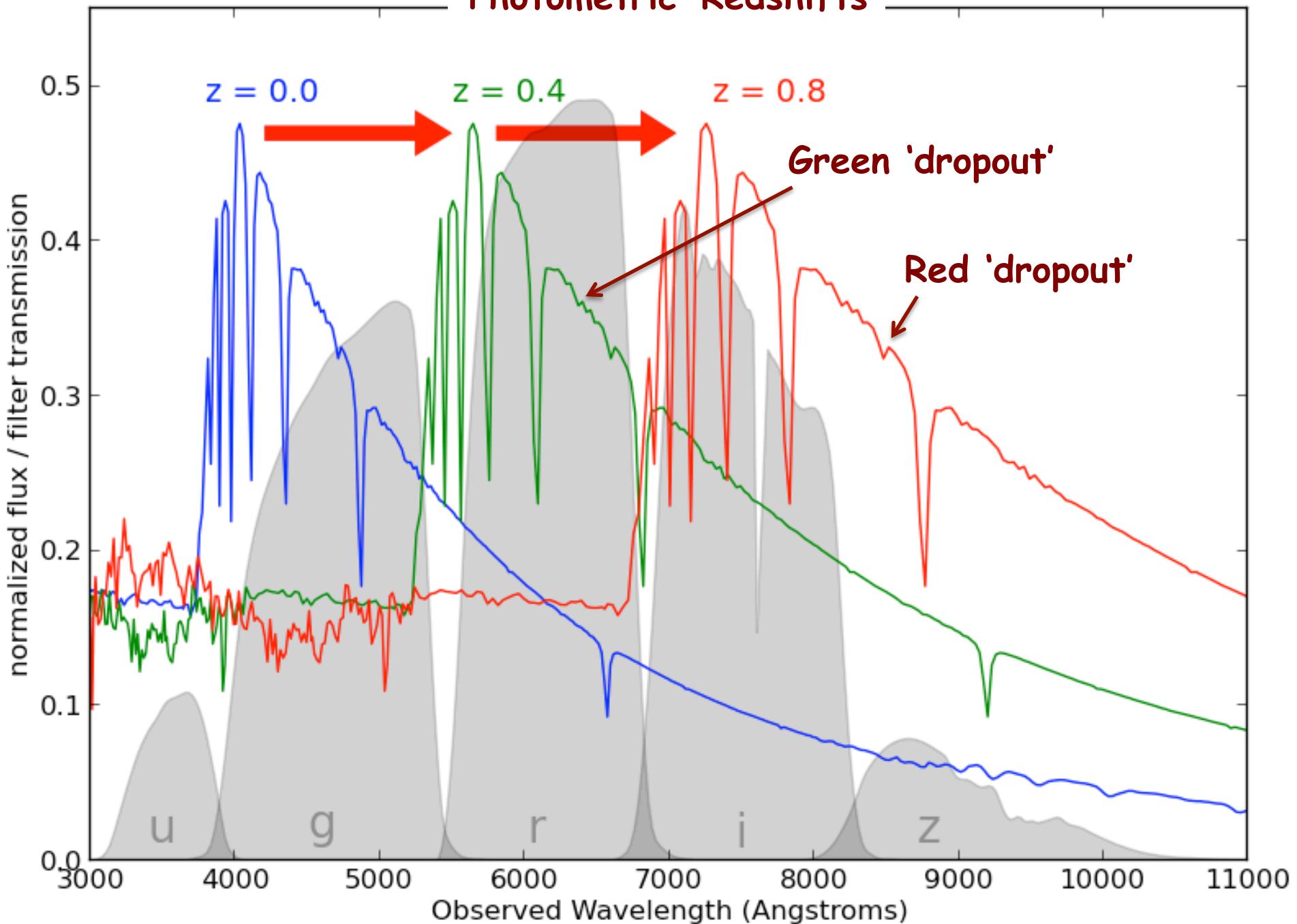


Image: HST WFPC2

Redshifts: Keck 10m LRIS

'Photometric' Redshifts



Wavelength: 0.5μ

V

0.7μ

i

Filters

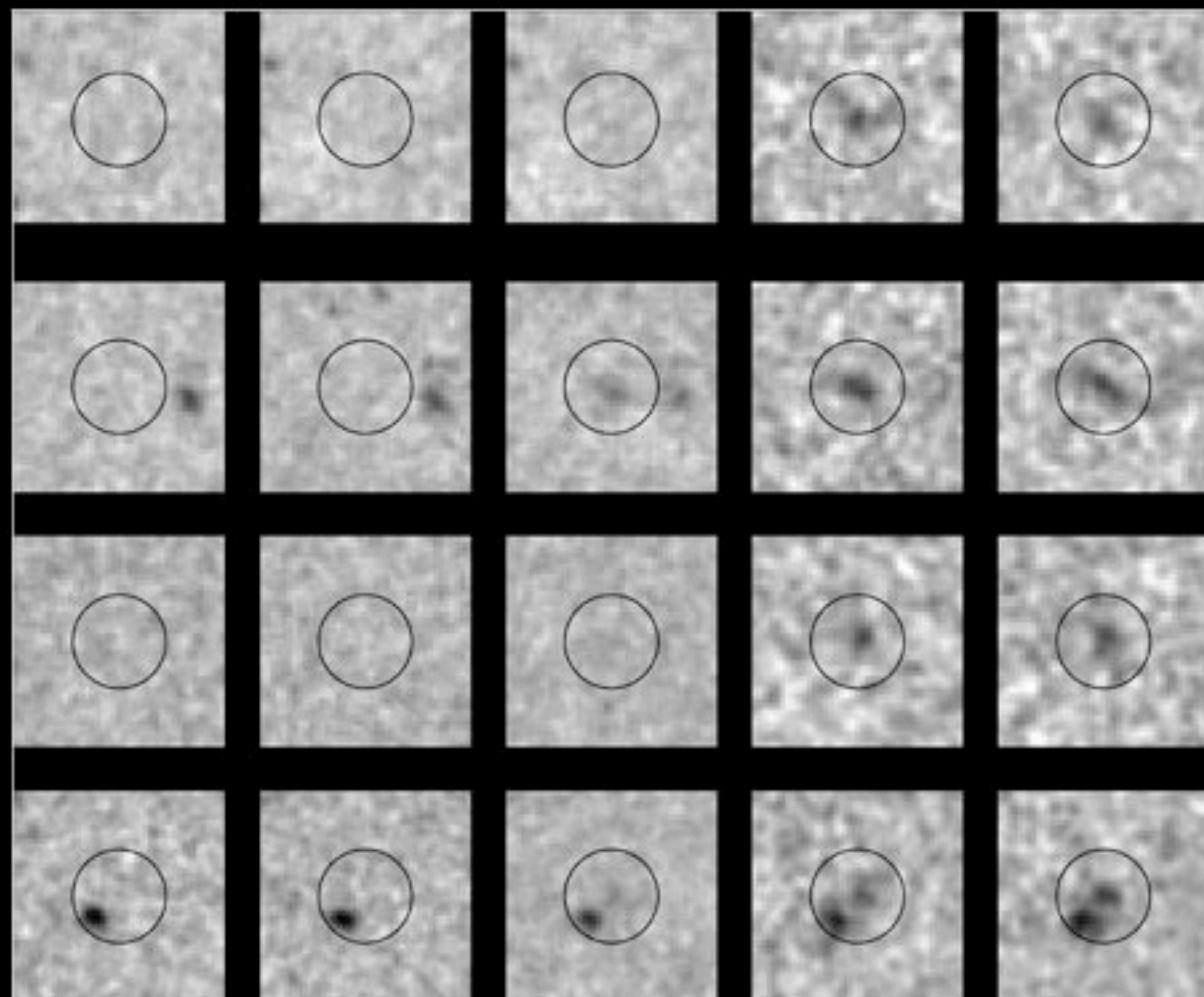
z

1.2μ

J

1.6μ

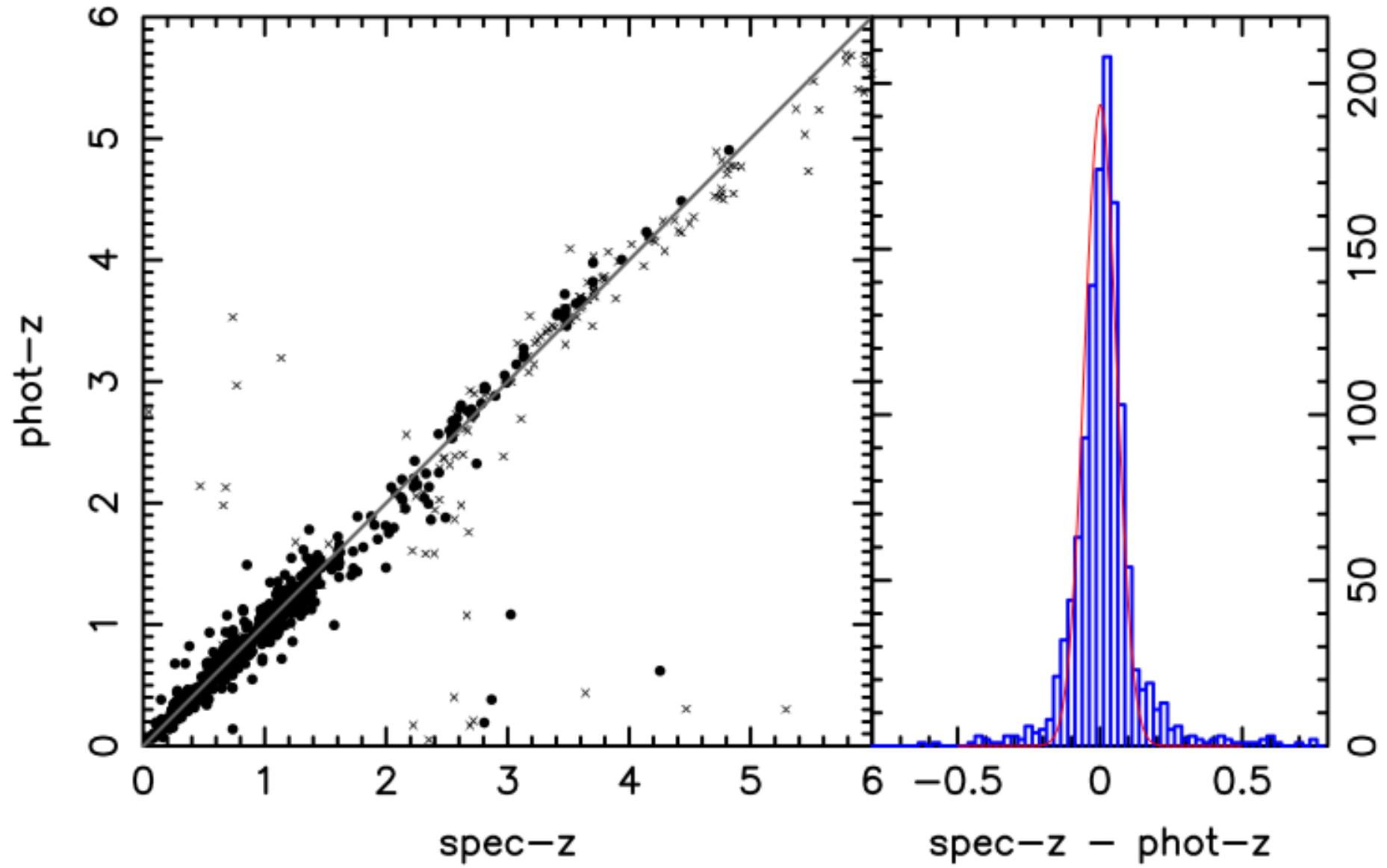
H

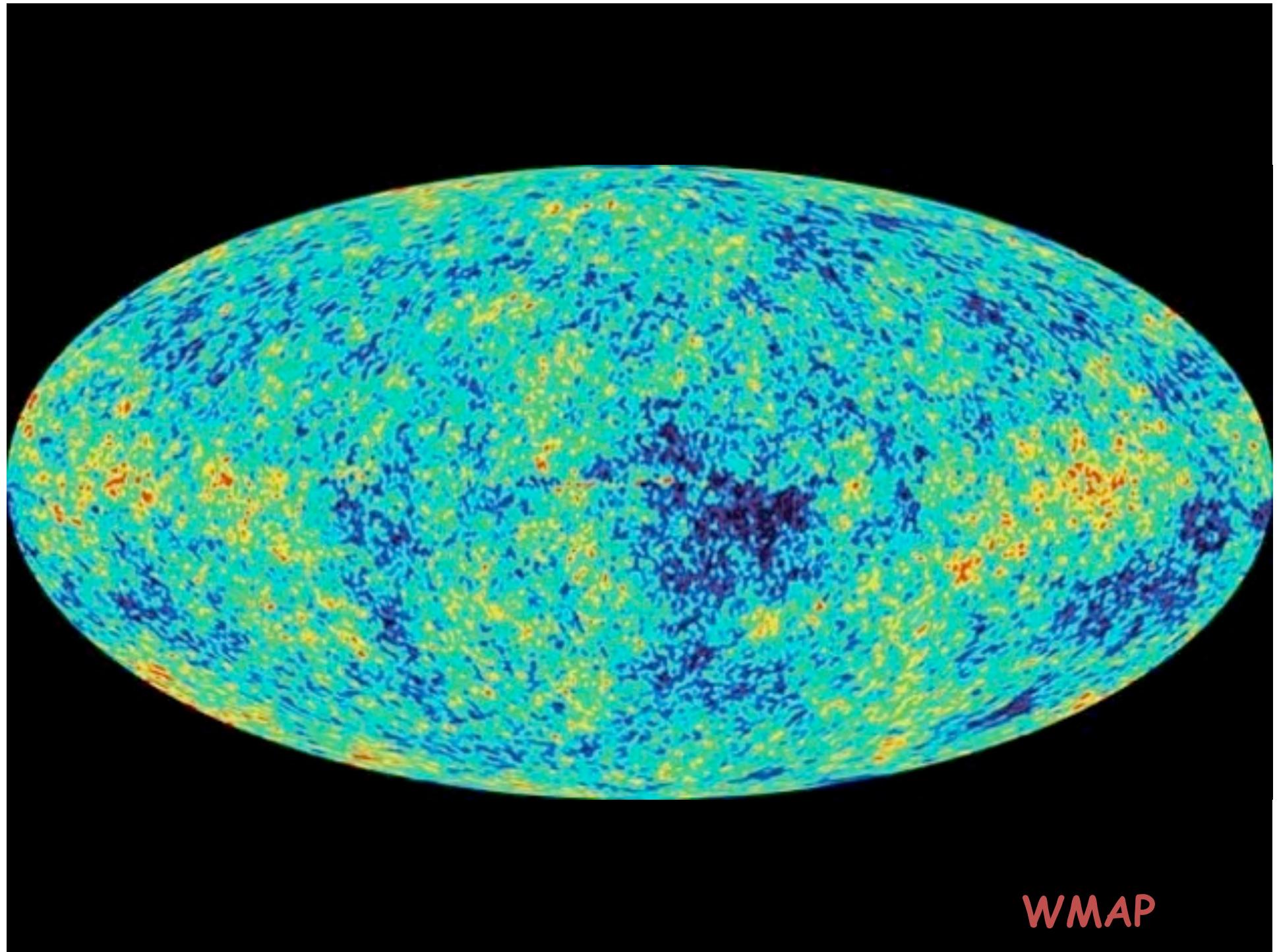


no detection

detection

Photometric Redshifts



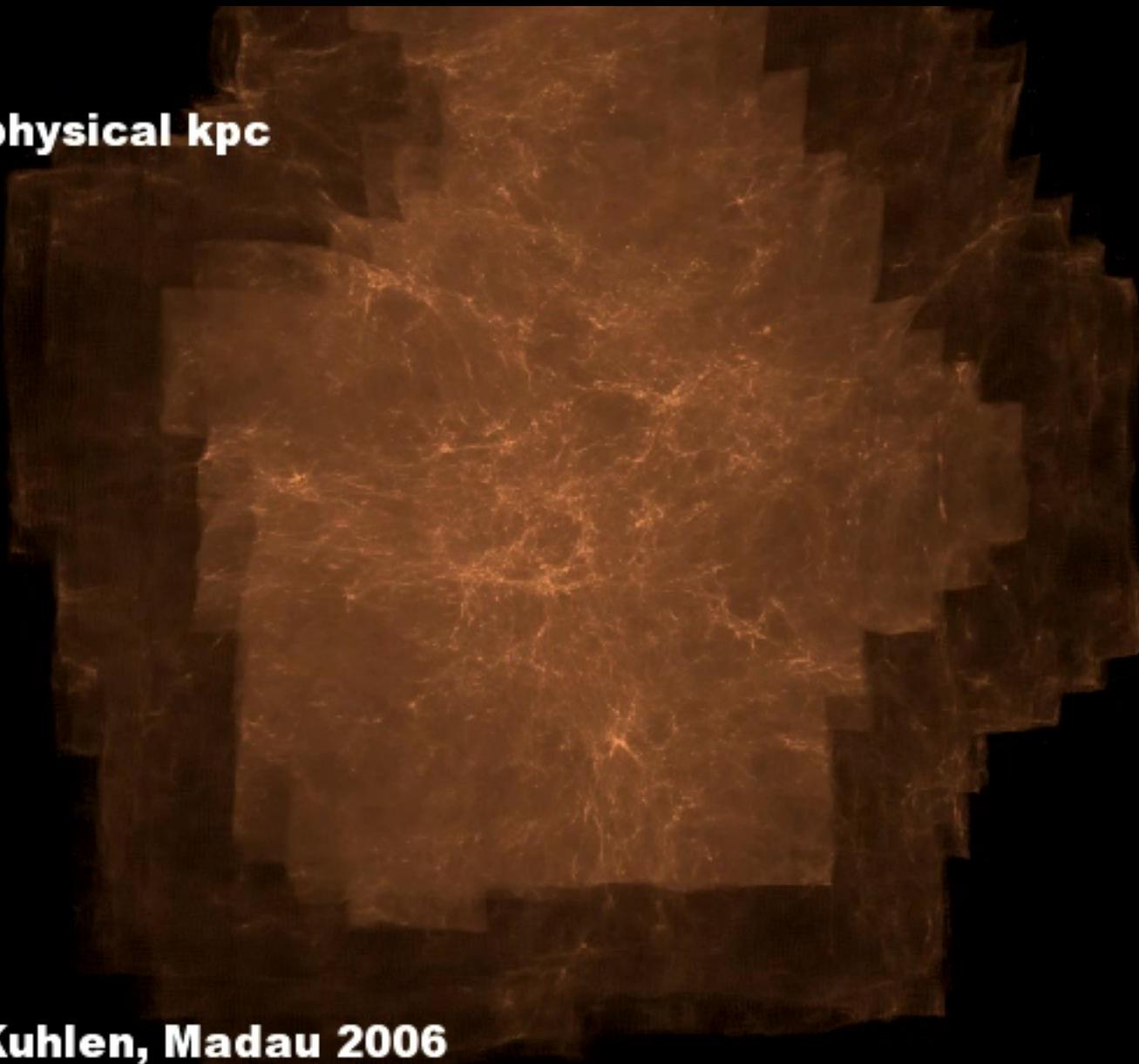


WMAP

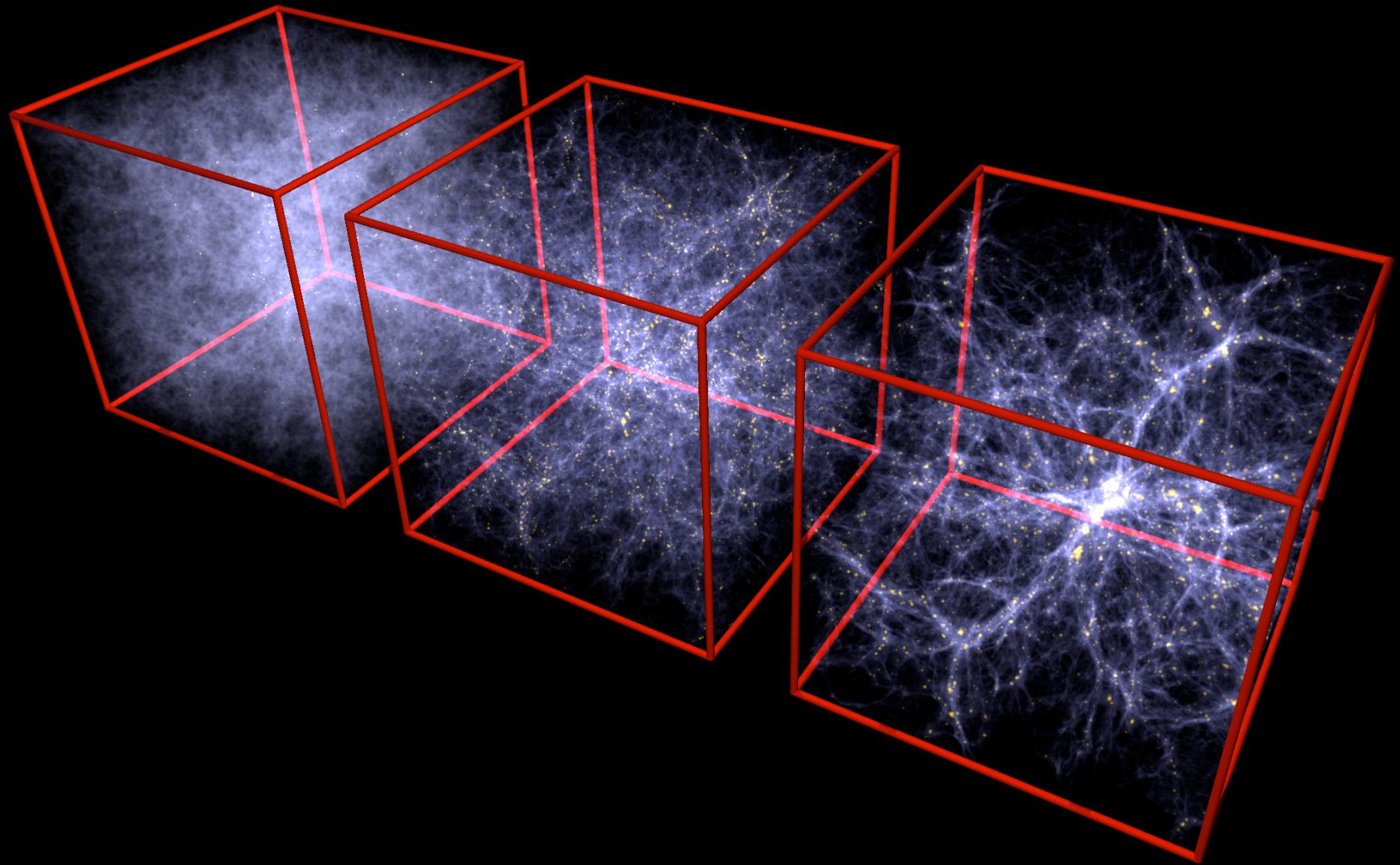
Computer Model of Evolving Universe

$z=11.9$

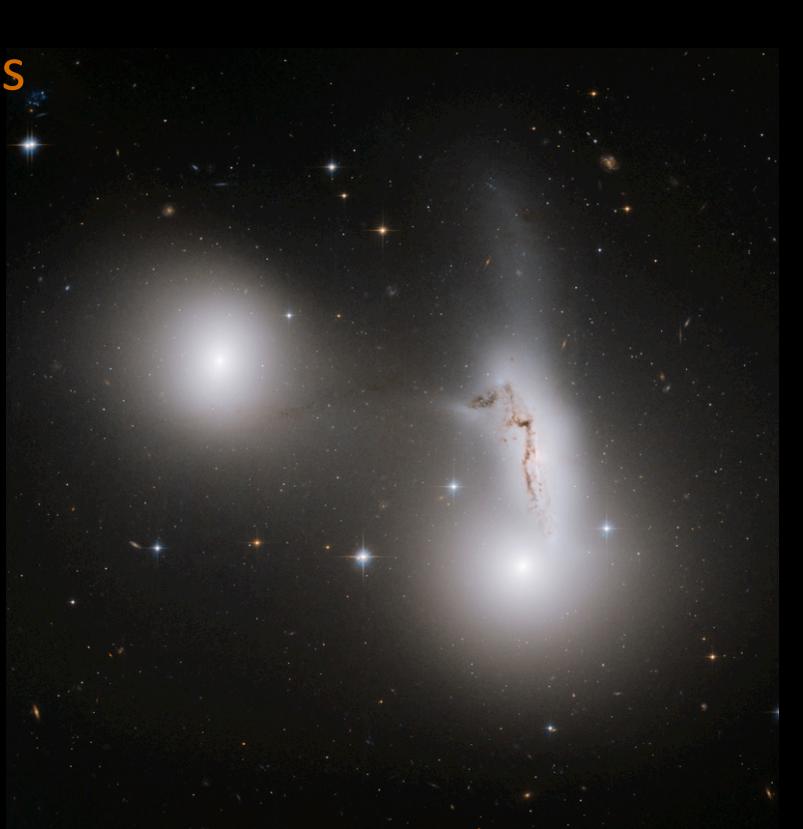
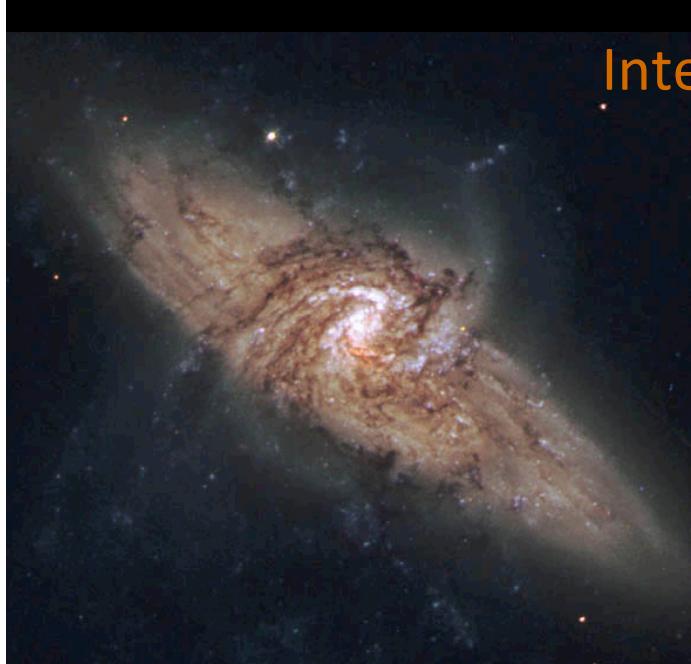
800 x 600 physical kpc



Diemand, Kuhlen, Madau 2006



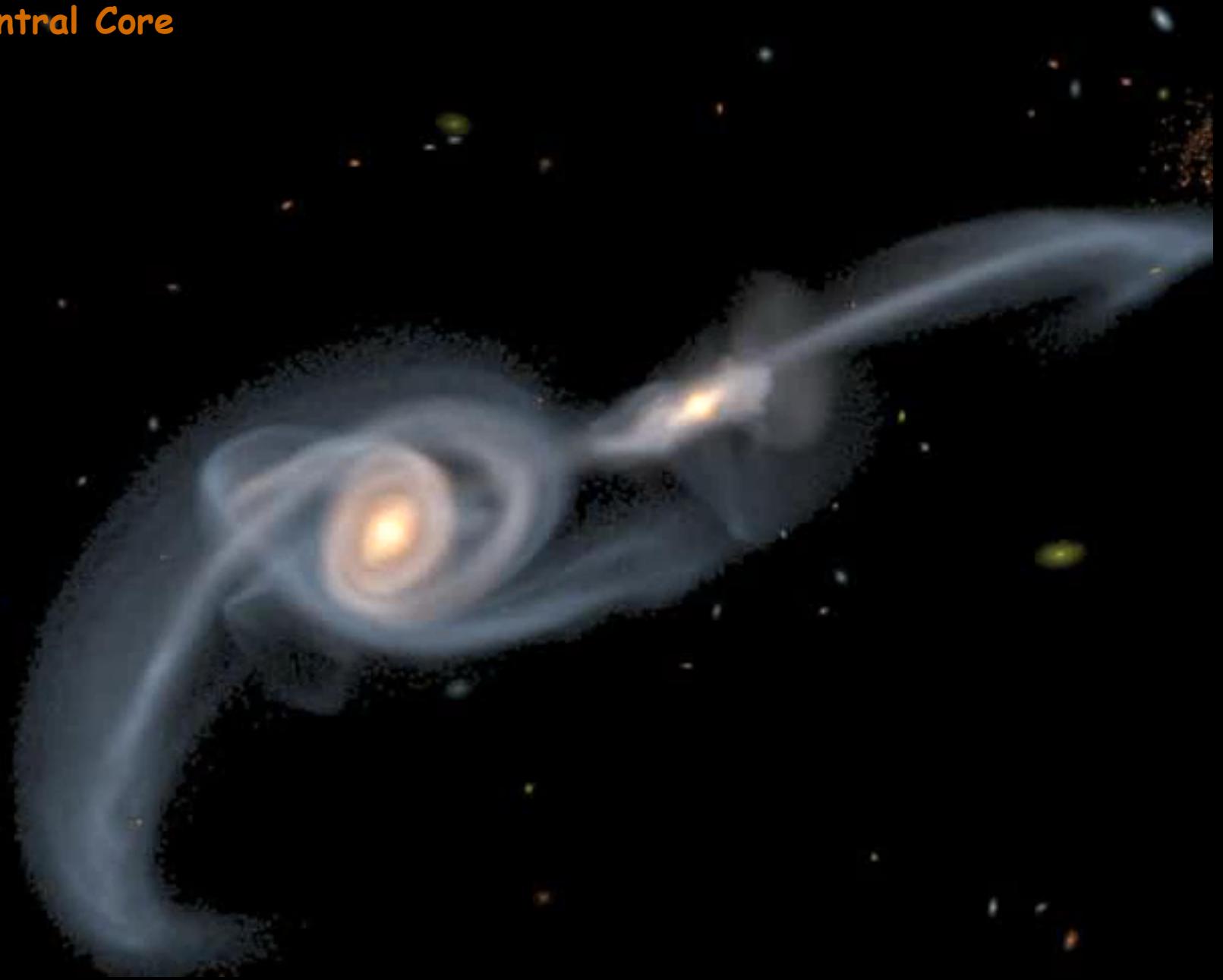
Interacting Galaxies



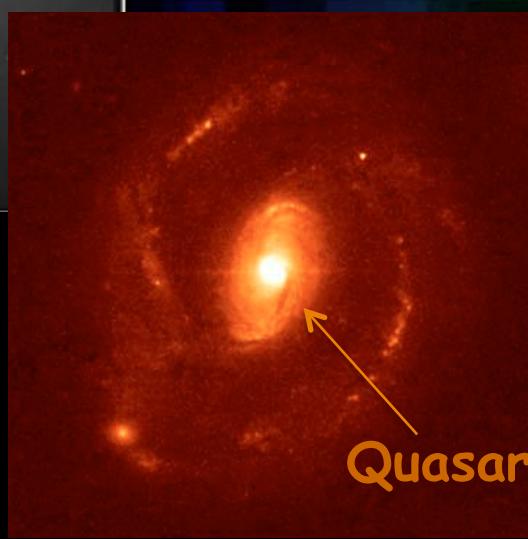
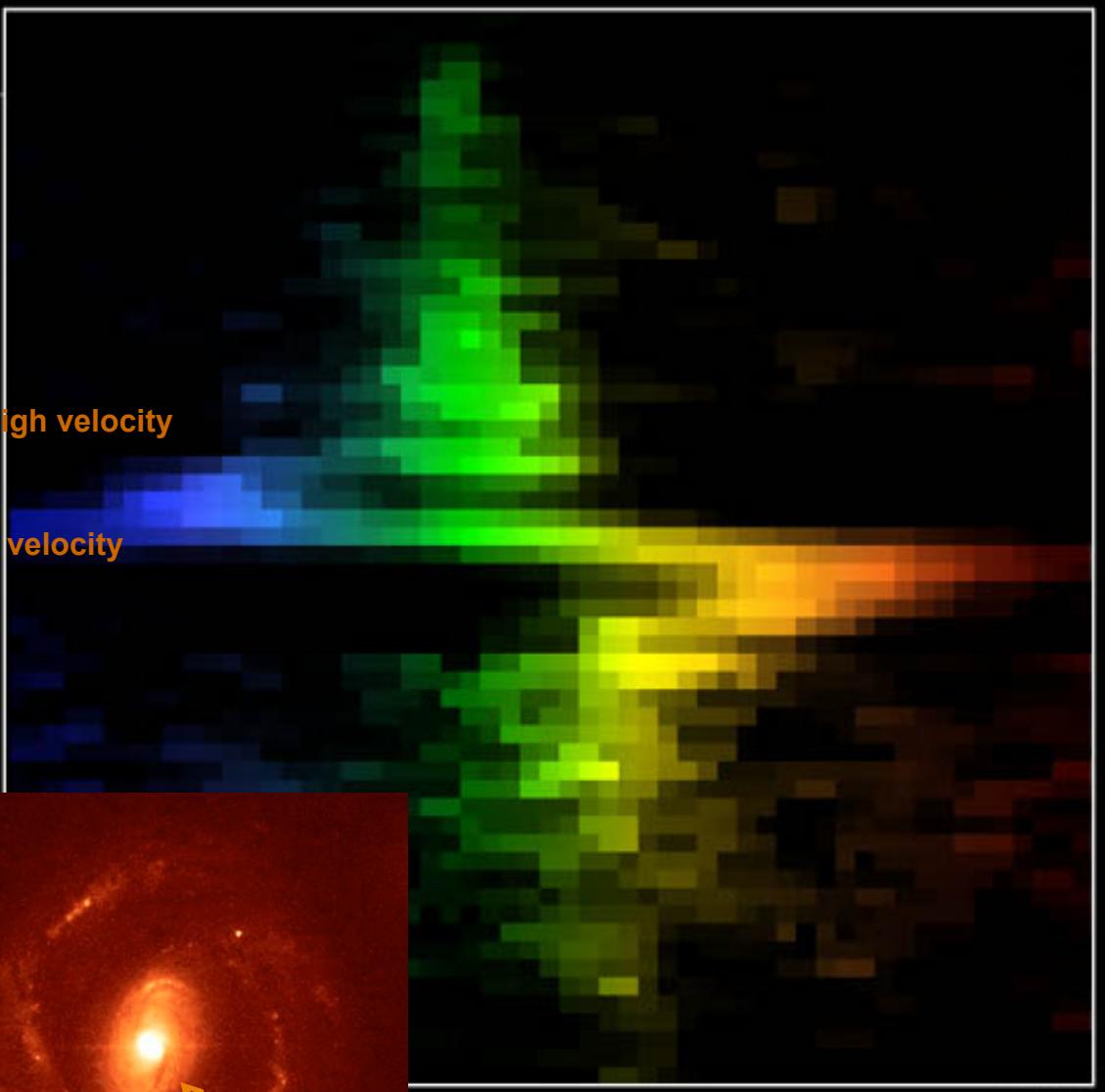
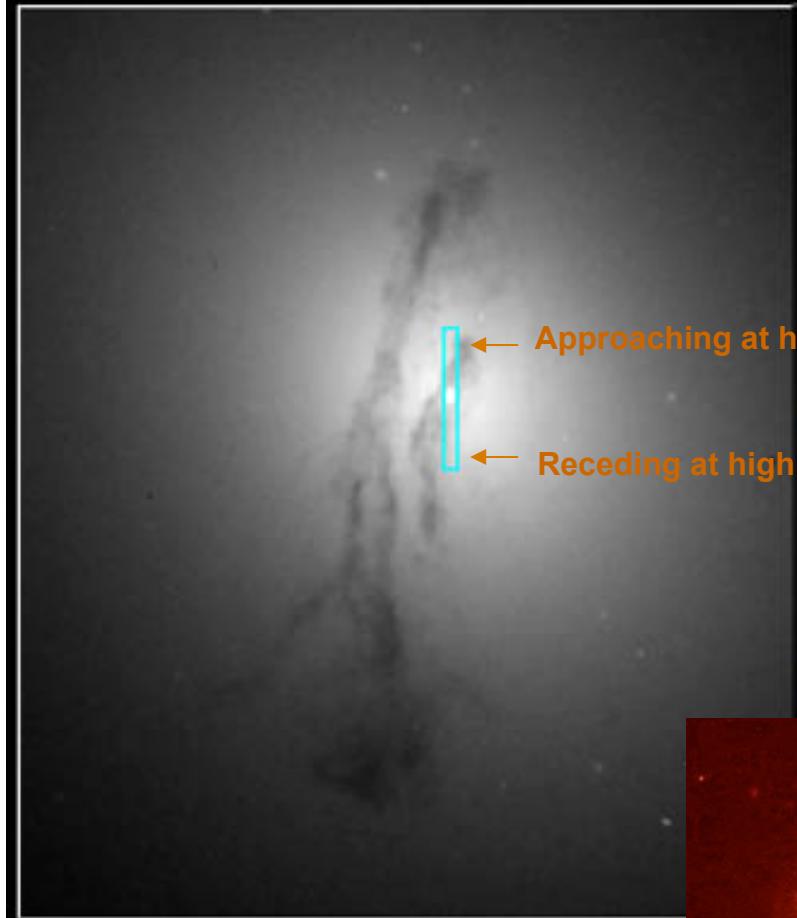
Computer Simulation of 2 Colliding Galaxies



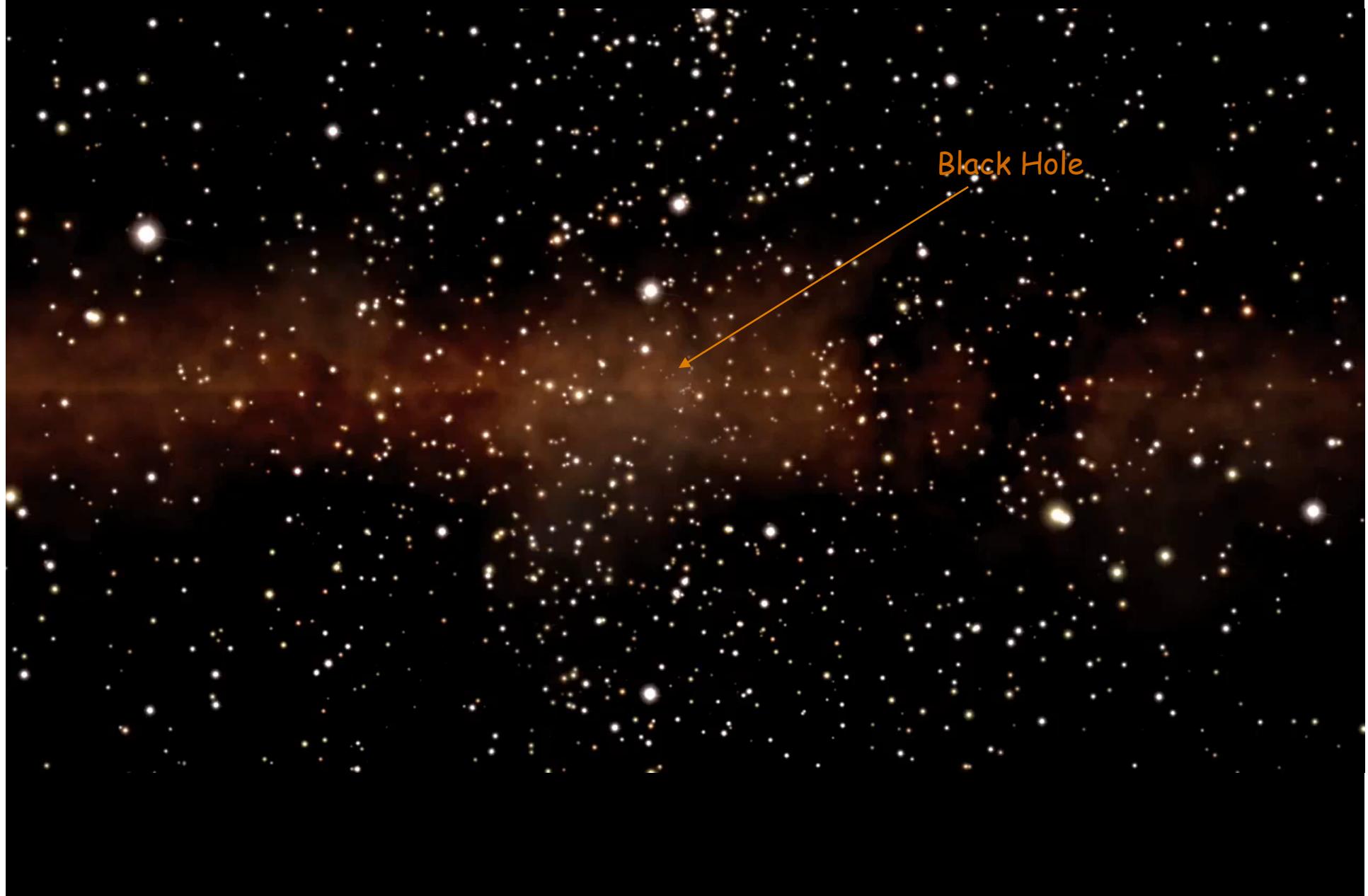
Formation of Massive Central Core



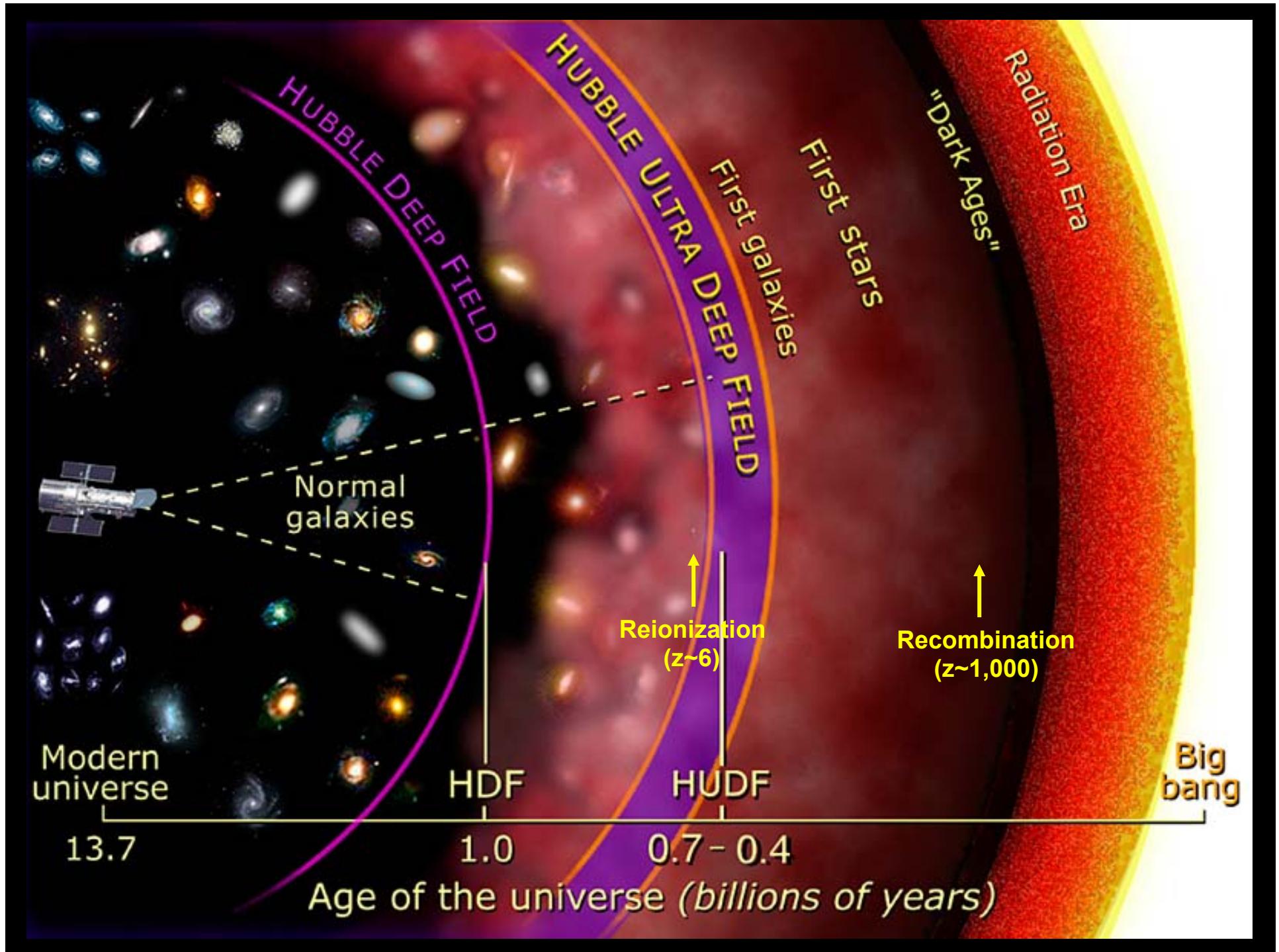
Galaxy Black Holes



Stars Orbiting Center of the Milky Way Galaxy



Black Hole



MACSJ0647.7+7015

