Astro 322
Jan. 21st

Winter 2009

Craig Heinke

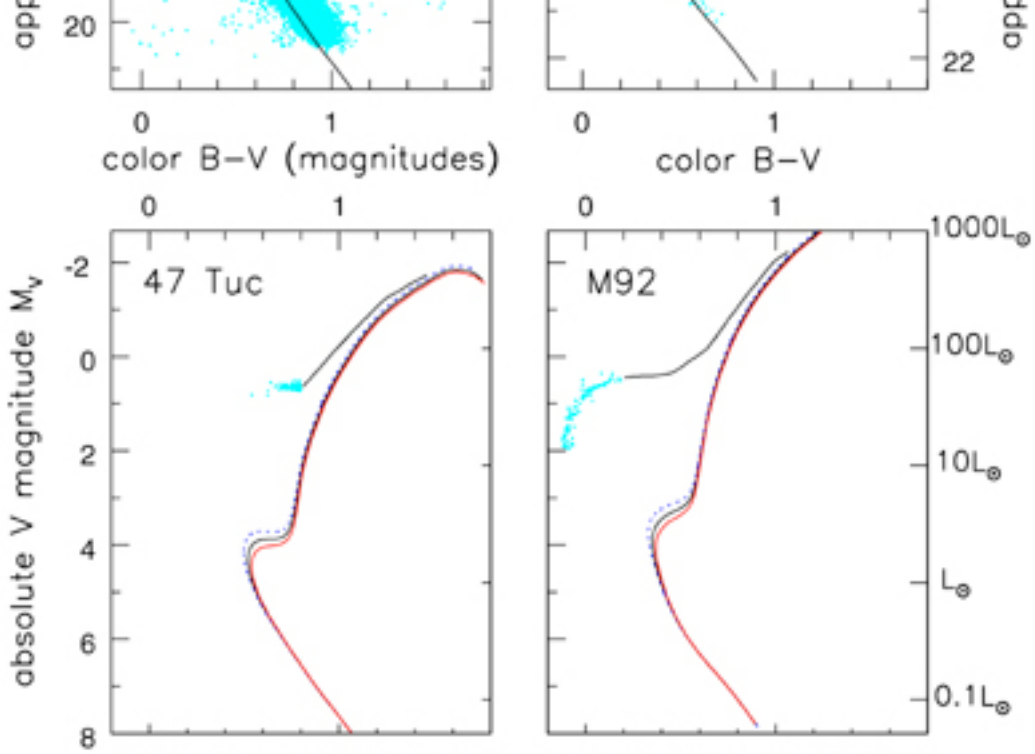


Fig 2.14 (P. Stetson) 'Galaxies in the Universe' Sparke/Gallagher CUP 2007

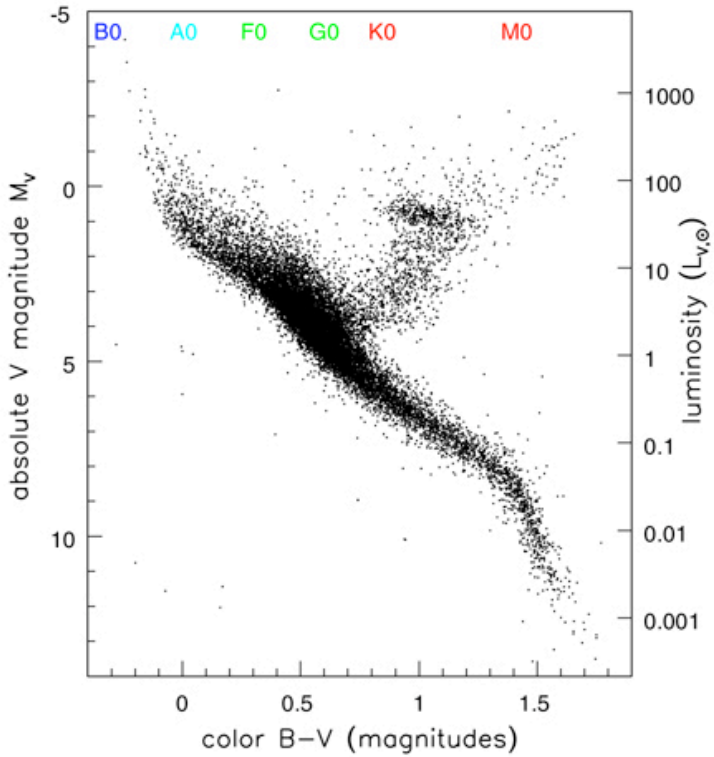


Fig 2.2 (Hipparcos)'Galaxies in the Universe' Sparke/Gallagher CUP 2007

For Problem 4, set 1:

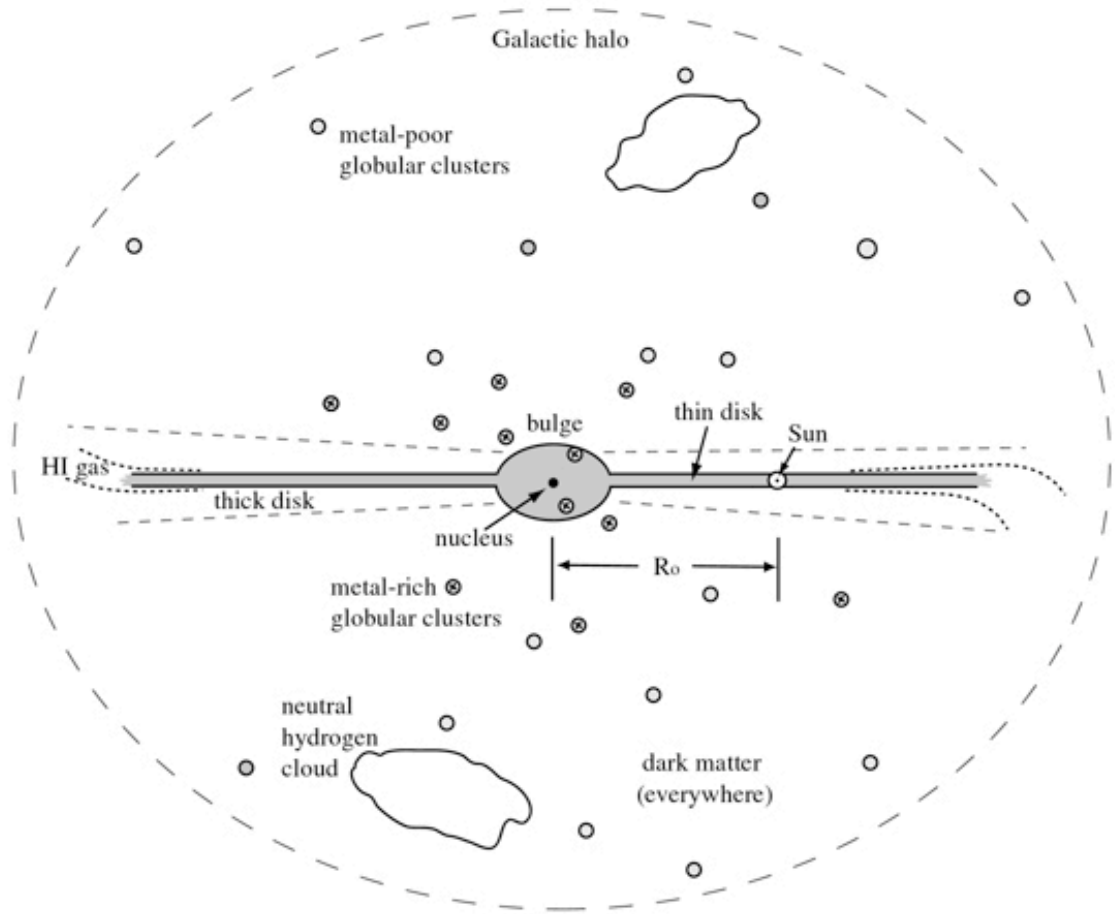
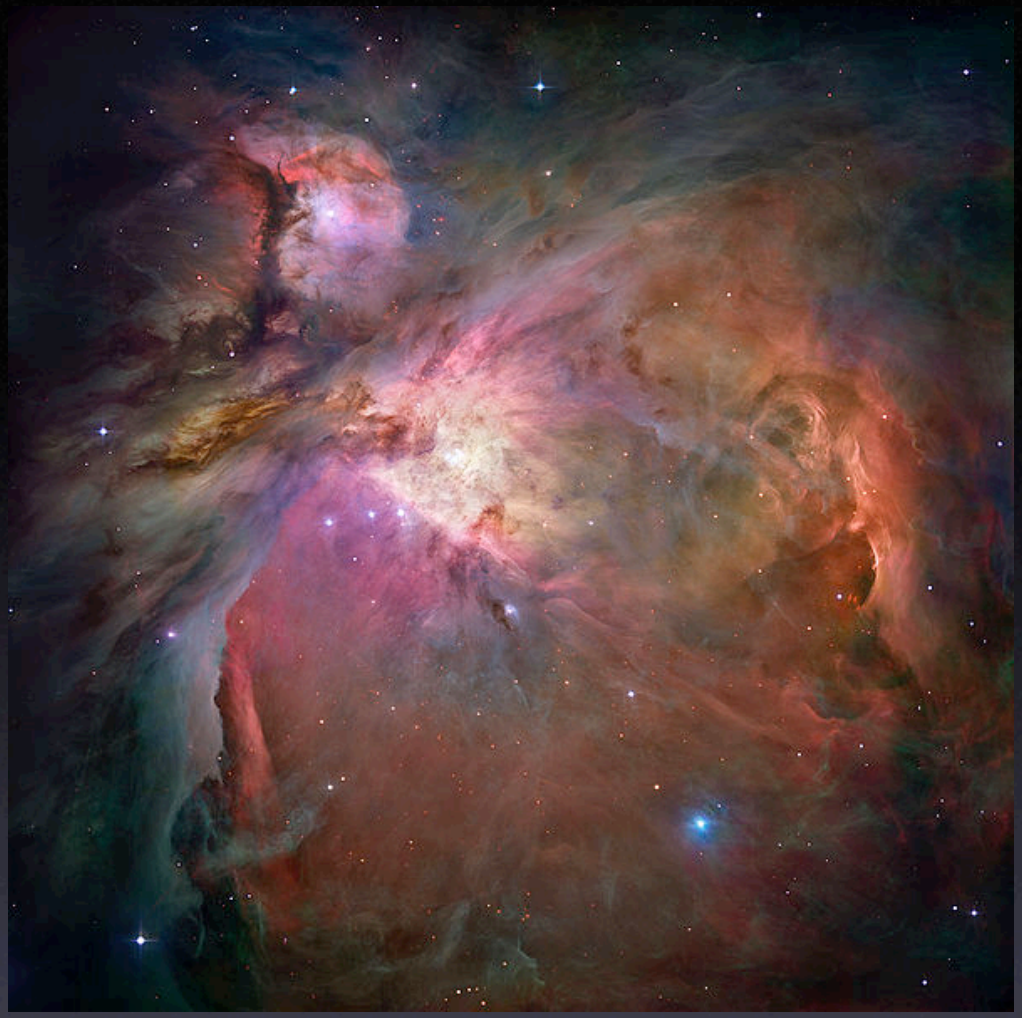


Fig 1.8 'Galaxies in the Universe' Sparke/Gallagher CUP 2007

HII Regions

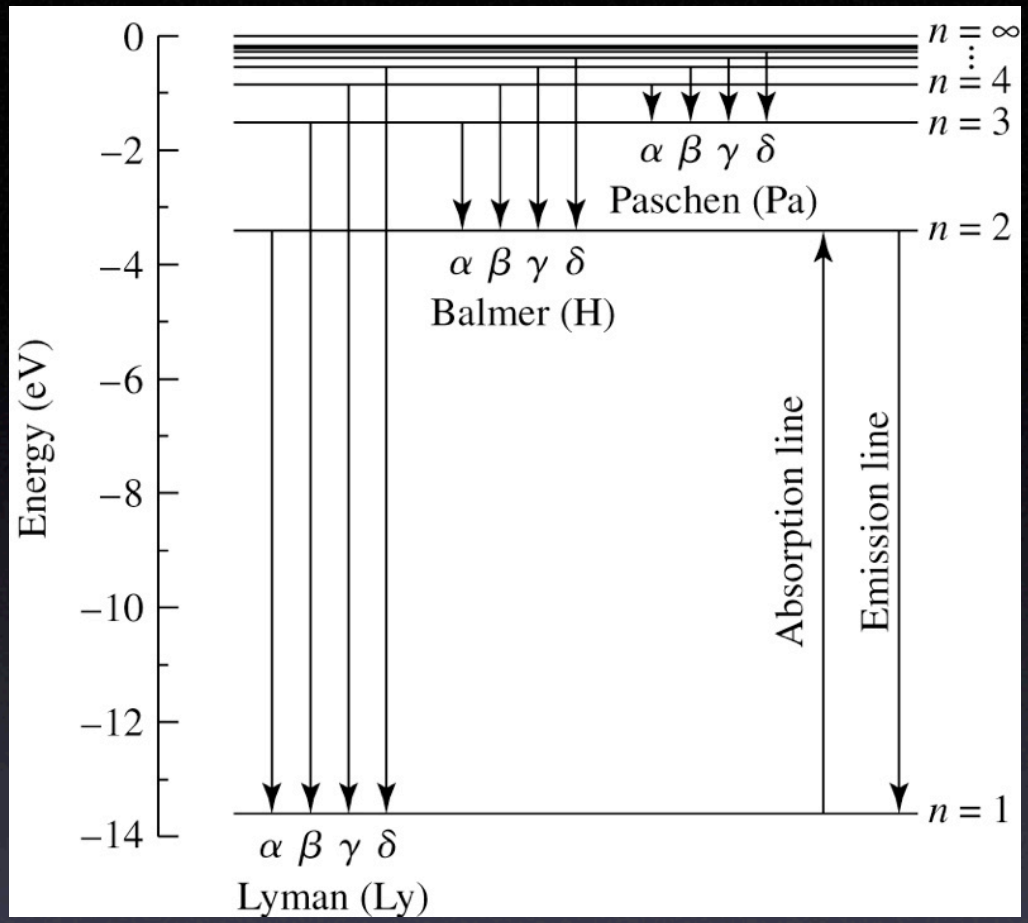
- Orion Nebula

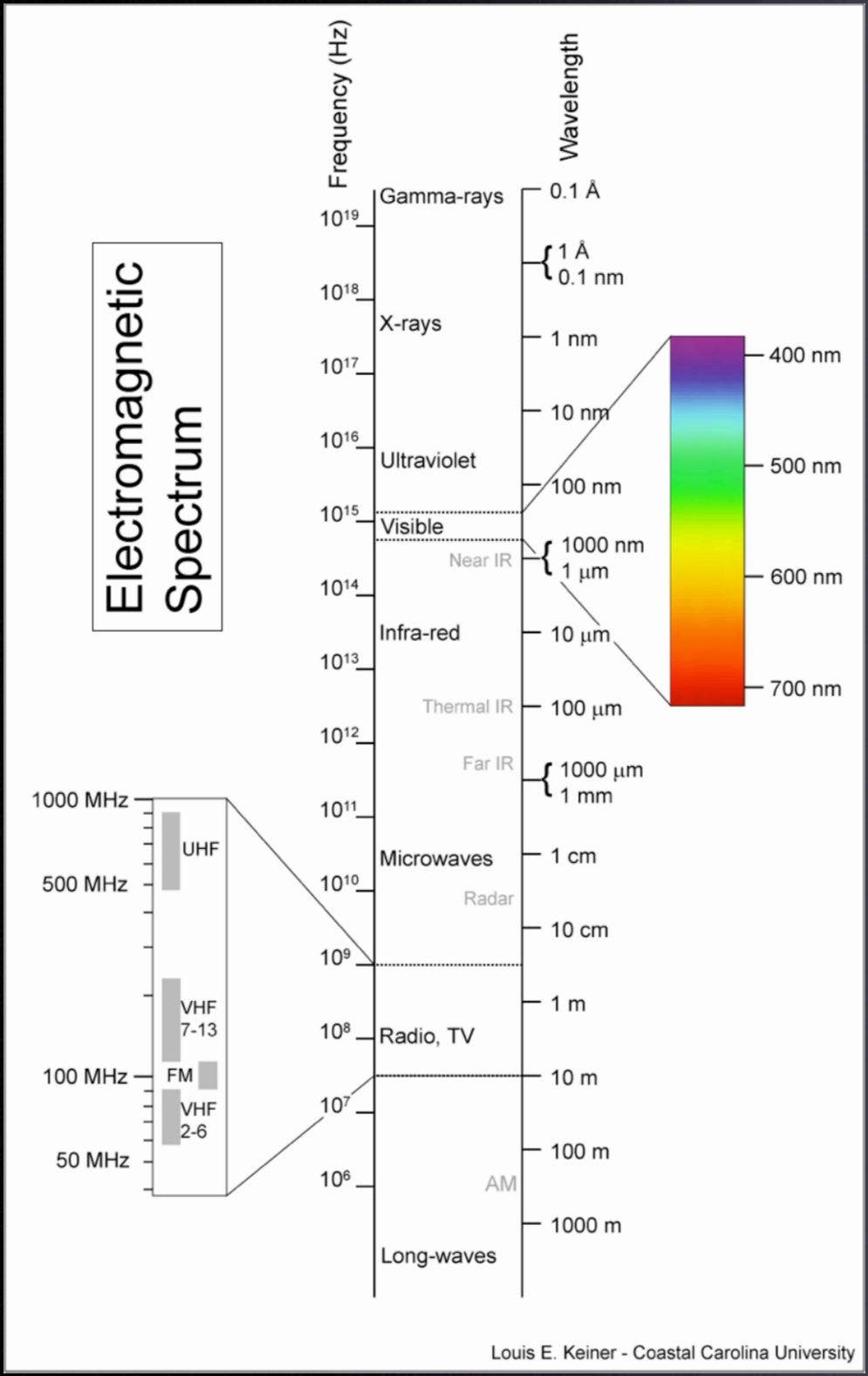


HST, NASA/ESA

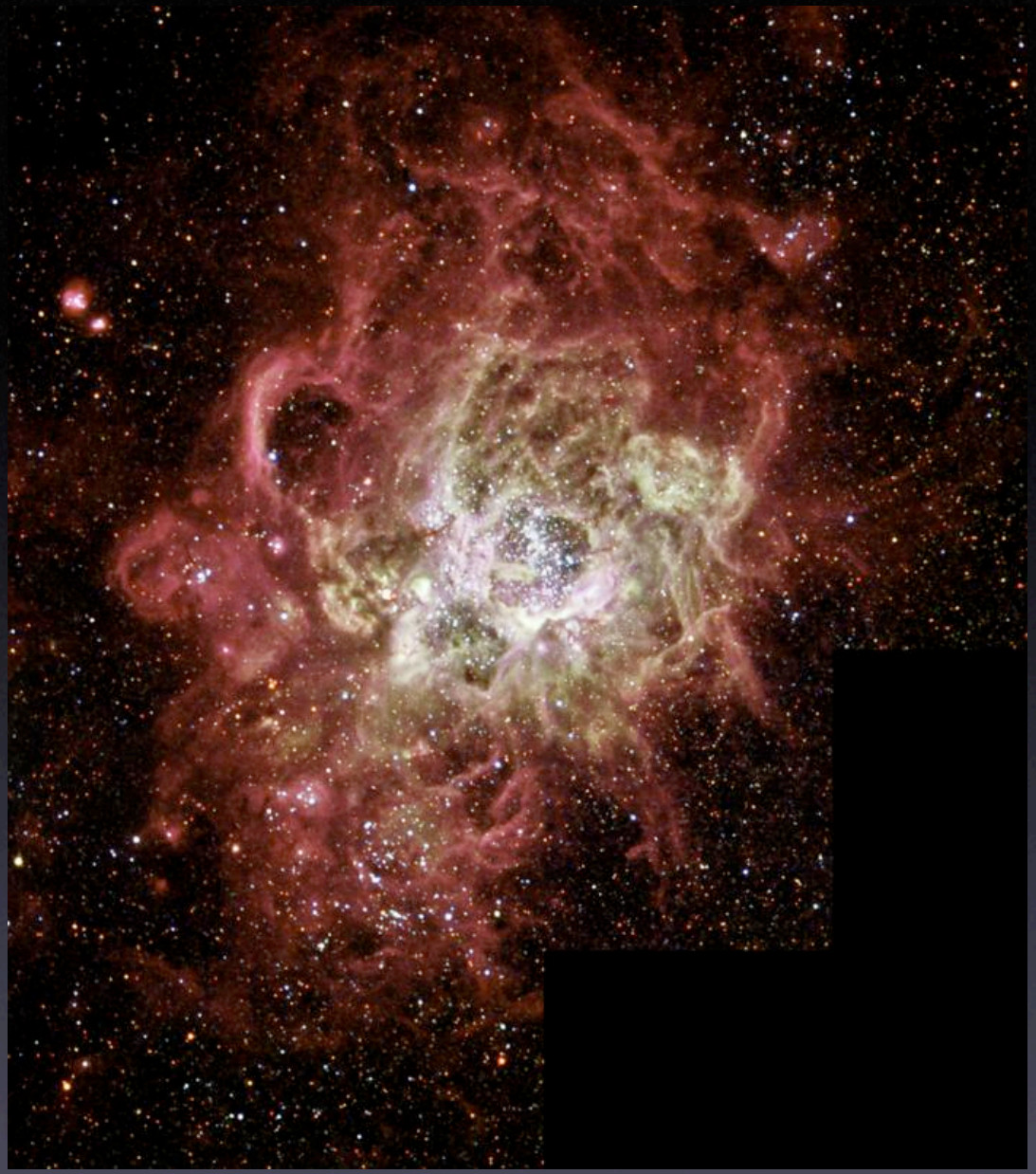
Trapezium stars in Orion Nebula (HST Optical/IR)

- Electronic transitions of hydrogen




Electromagnetic Spectrum
Frequency (Hz)
Wavelength
Gamma-rays
X-rays
Ultraviolet
Visible
Near IR
Infra-red
Thermal IR
Far IR
Microwaves
Radar
Radio, TV
AM
Long-waves
10^{19}
10^{18}
10^{17}
10^{16}
10^{15}
10^{14}
10^{13}
10^{12}
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
0.1 Å
1 Å
0.1 nm
1 nm
10 nm
100 nm
1000 nm
1 μm
10 μm
100 μm
1000 μm
1 mm
1 cm
10 cm
1 m
10 m
100 m
1000 m
400 nm
500 nm
600 nm
700 nm
1000 MHz
500 MHz
100 MHz
50 MHz
UHF
VHF 7-13
FM
VHF 2-6
Louis E. Keiner - Coastal Carolina University

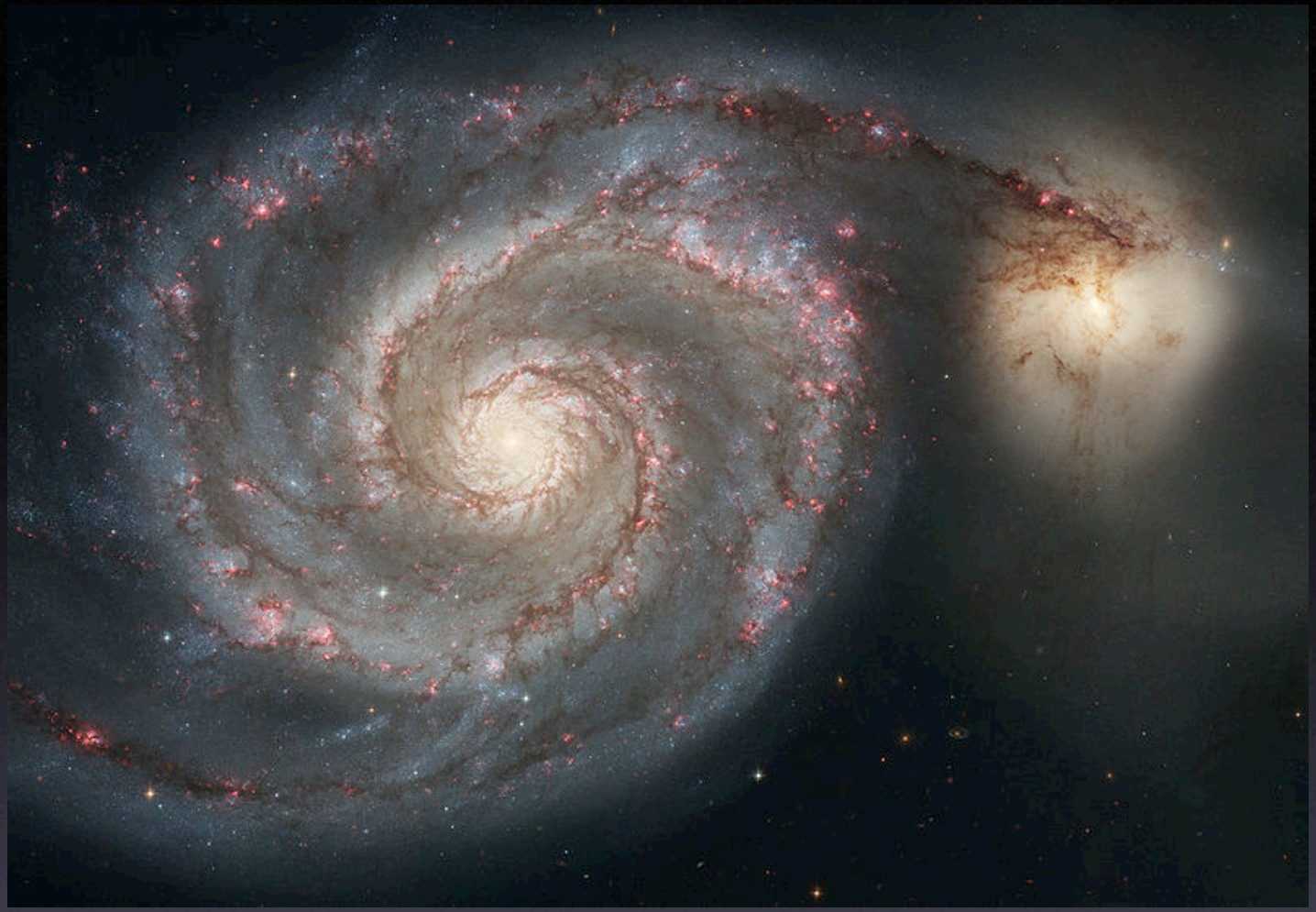
- NGC 604 in M33; 100x size of Orion



Carina Nebula

Hubble Heritage

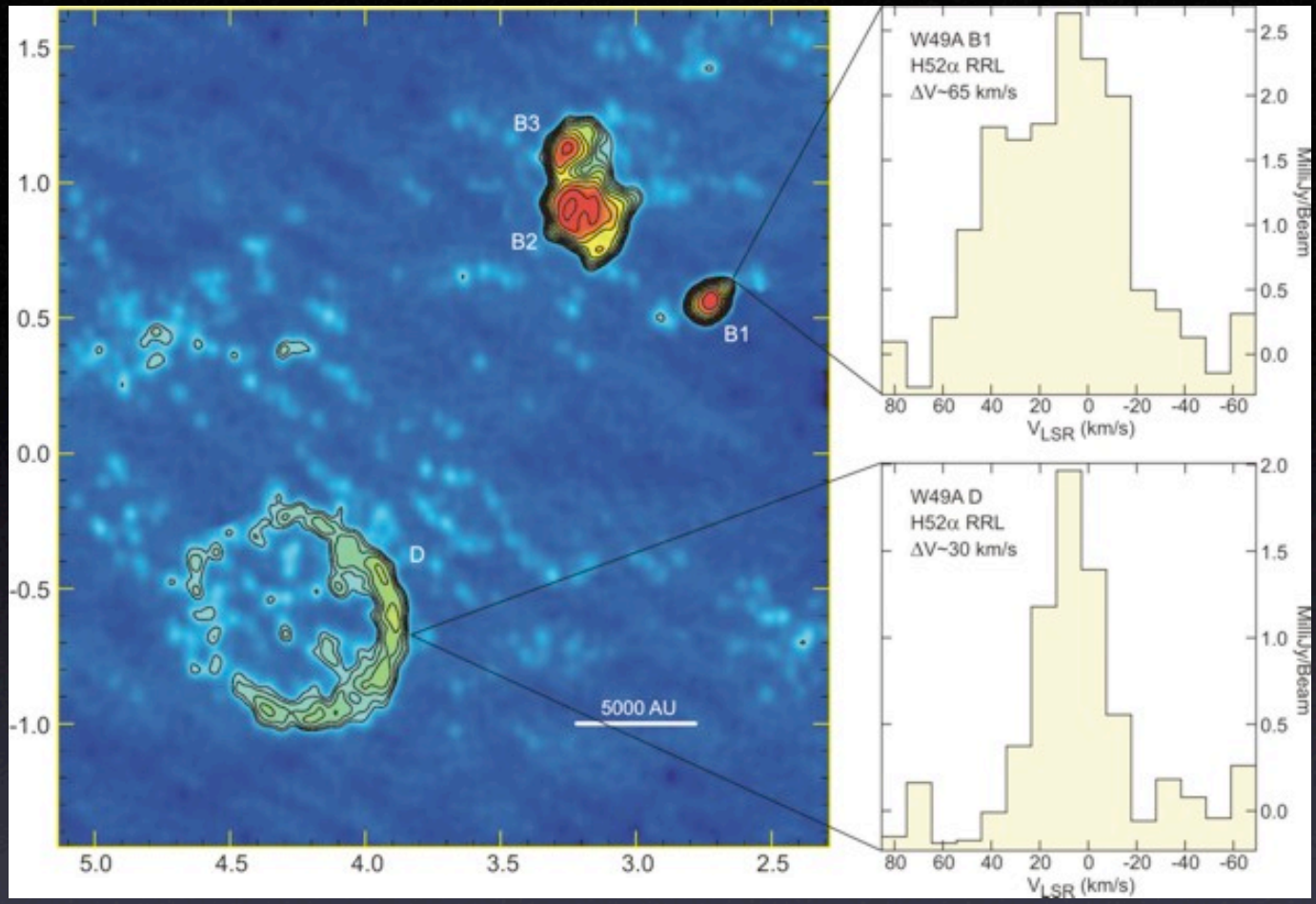
NASA, ESA, N. Smith (University of California, Berkeley), and The Hubble Heritage Team (STScI/AURA)
Hubble Space Telescope ACS/WFC • STScI-PRC07-16a



M51, HST

- Cold molecular: H_2, ρ>200 molecules/cm^{-3}, T<100 K, M~2e9 M_{sun}, Volume~0.1% of Galaxy
- Cold atomic gas: HI, ρ~25 cm^{-3}, T~100 K, M~3e9, V~2%
- Warm atomic gas: HI, ρ~0.3, T~8000 K, M~2e9, V~35%
- Diffuse ionized gas: HII, ρ~0.15, T~8000 K, M~1e9, V~20%
- HII regions: HII, $1<\rho<10^4$, T~10000 K, M~5e7, V<0.1%
- Hot X-ray gas: HII, ρ~0.002, T~10^6 K, M~1e8, V~45%

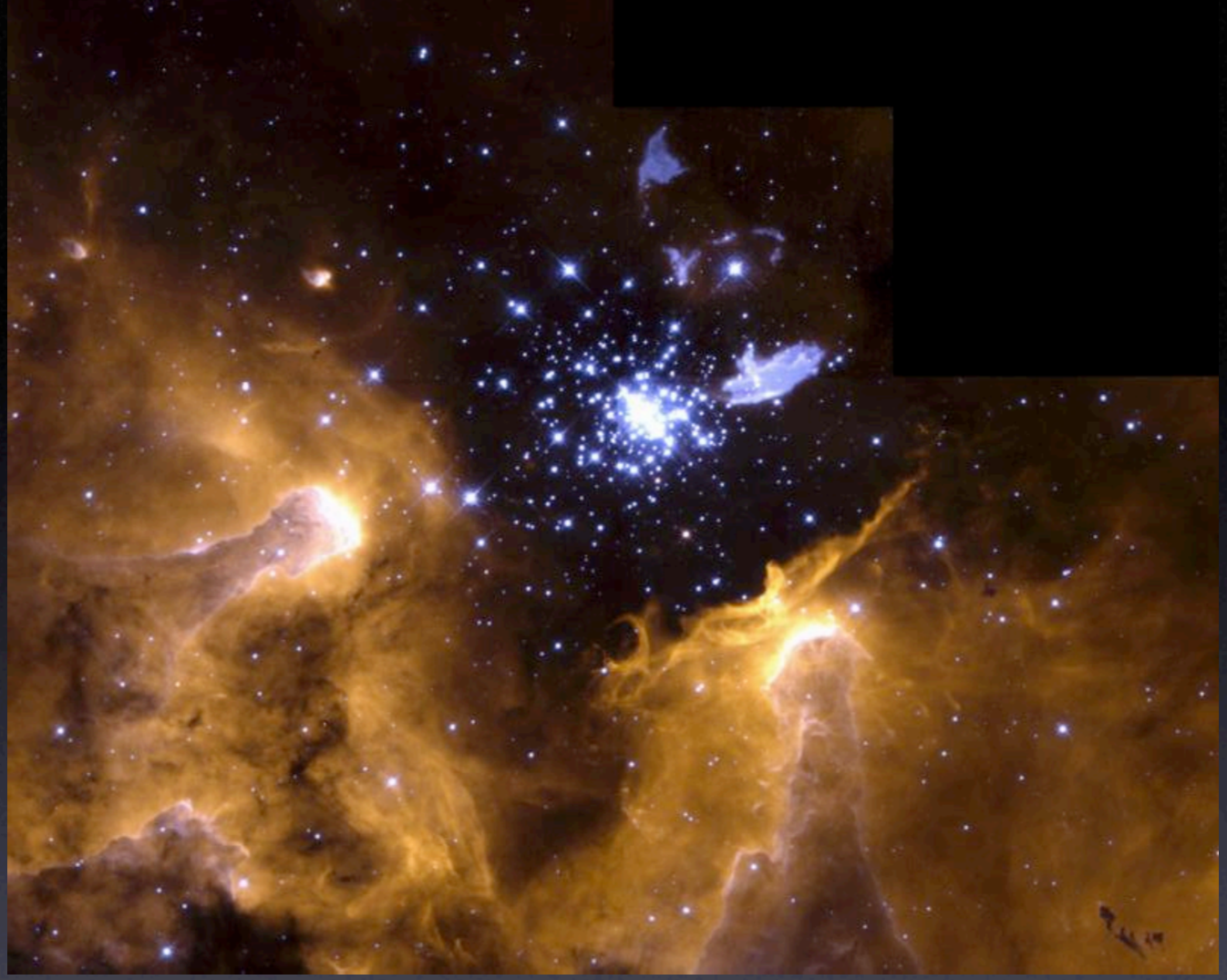
Ultracompact HII regions
Radio recombination lines, VLA



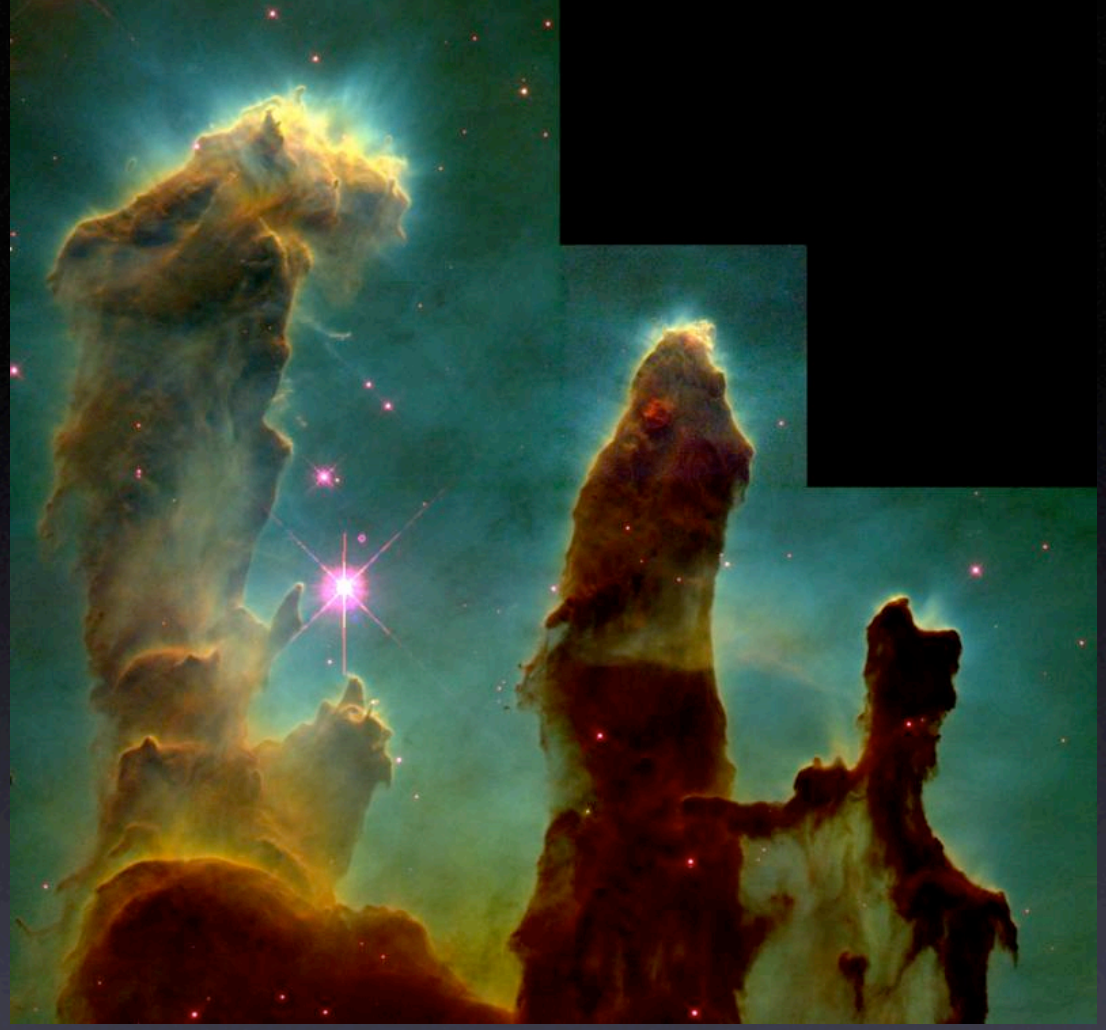
- NGC 346, in SMC

Pismis 24,
HST

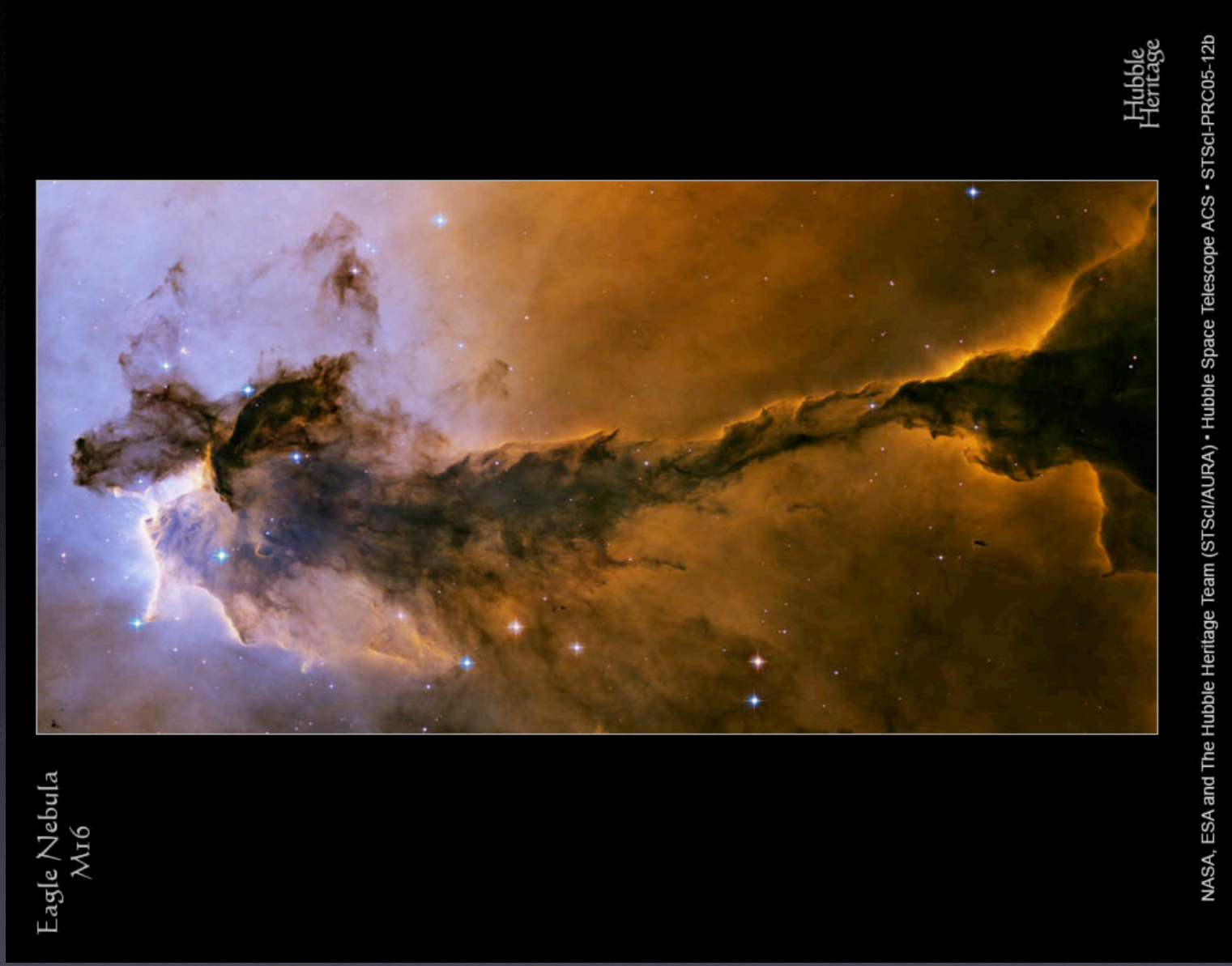
- NGC 3603

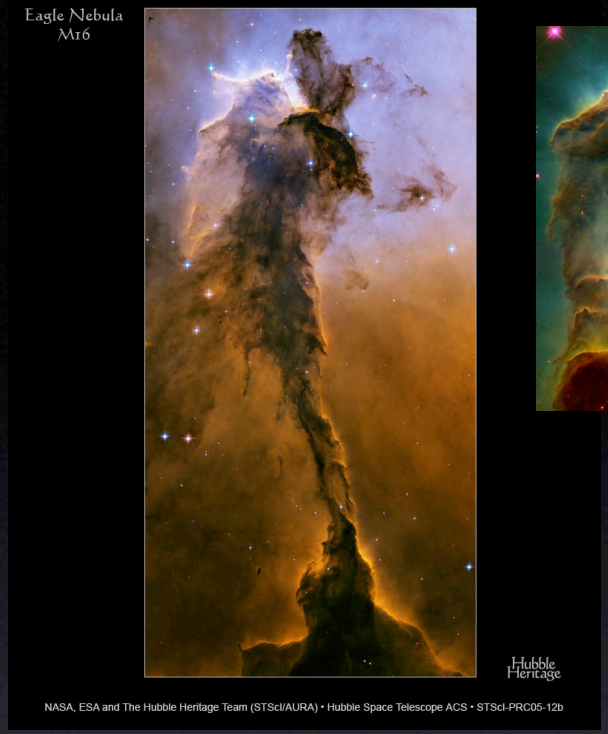


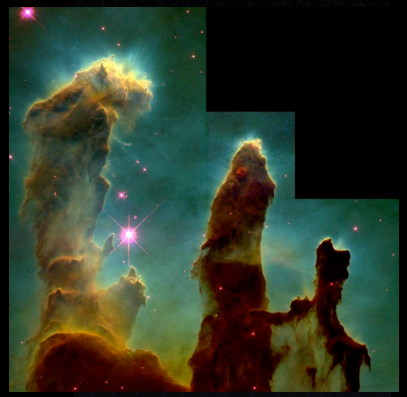
- Eagle Nebula

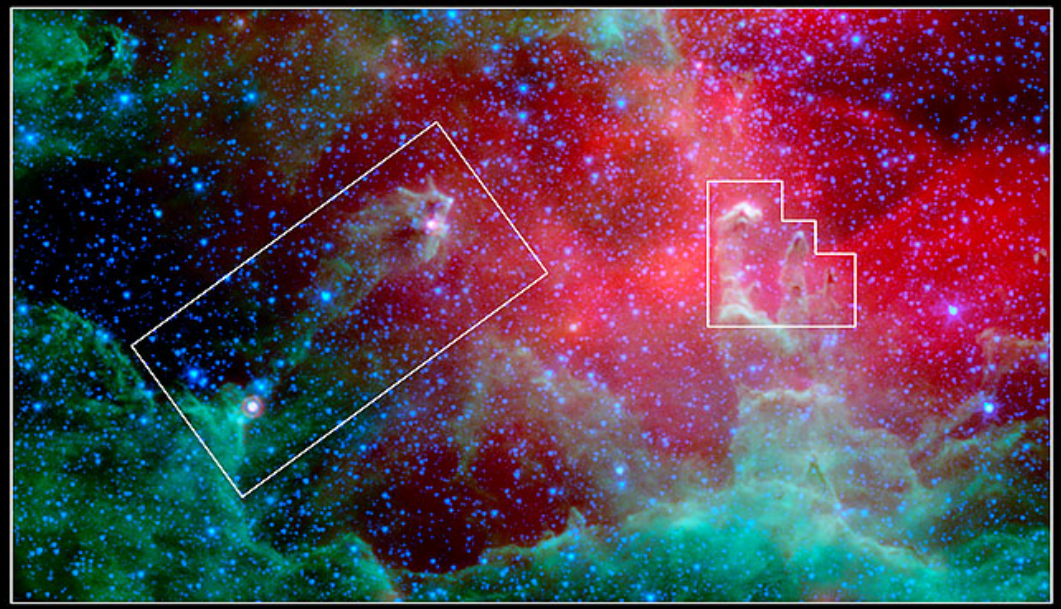


Eagle Nebula









Protostars in the Eagle

- Proplyd in Orion disk

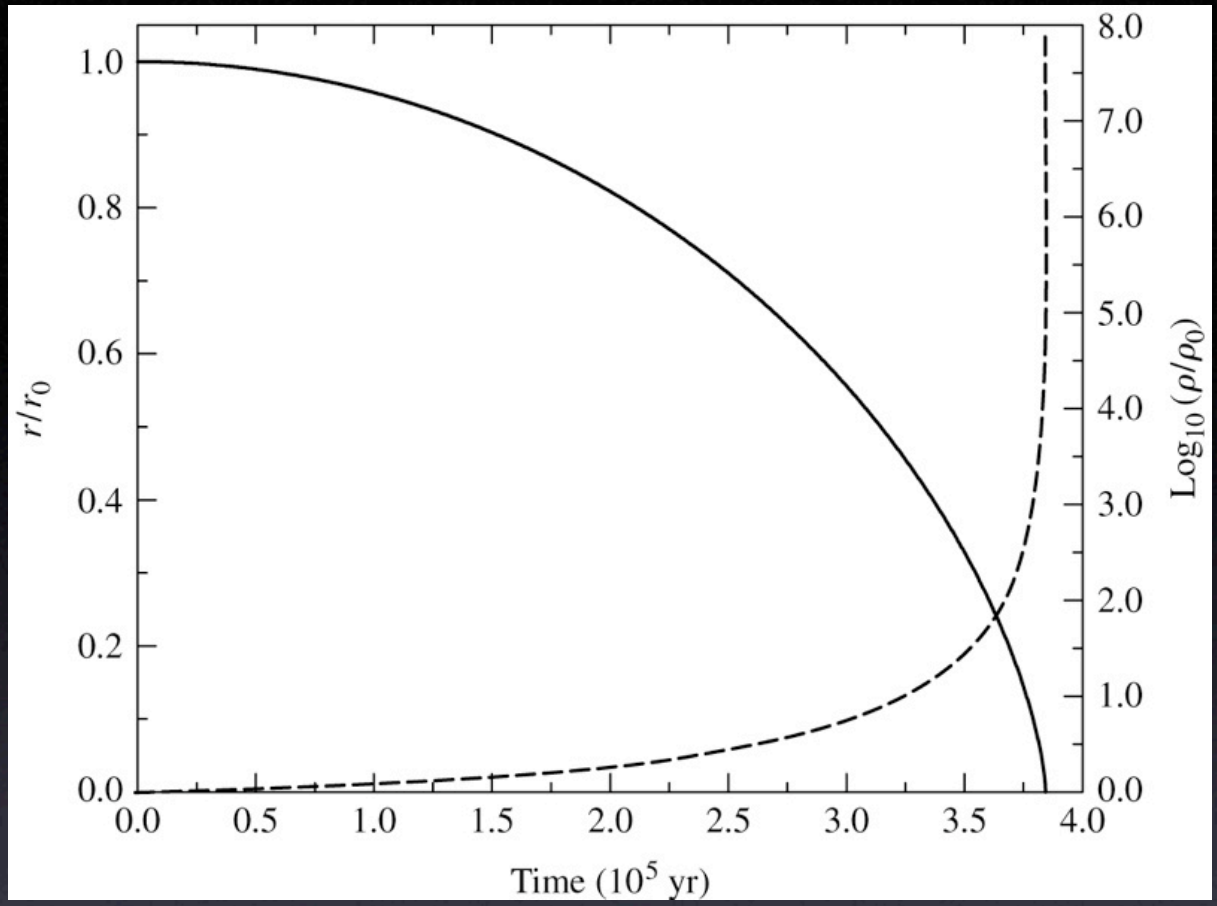
Edge-On Protoplanetary Disk
Orion Nebula

HST • WFPC2

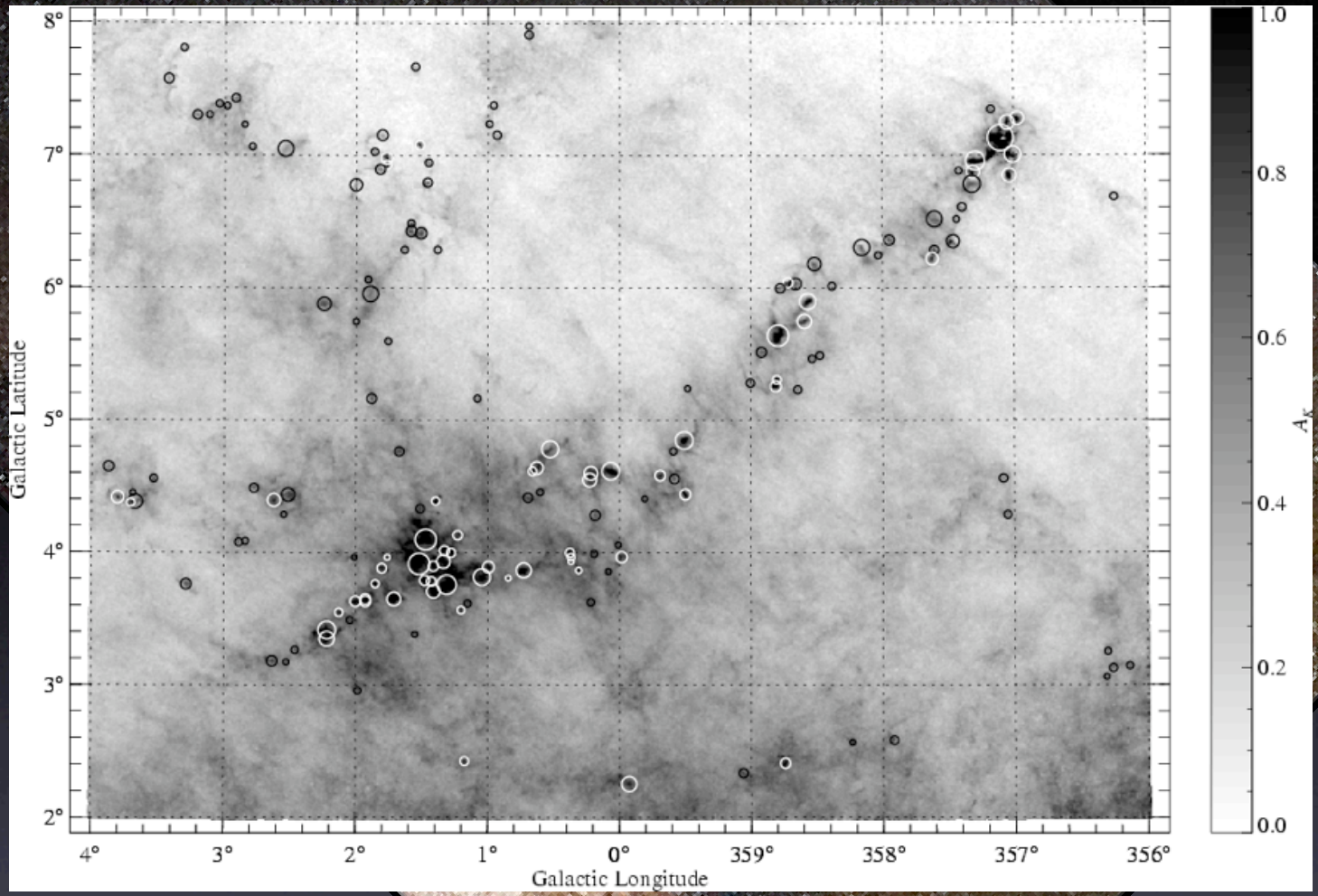
PRC95-45c · ST ScI OPO · November 20, 1995
M. J. McCaughrean (MPIA), C. R. O'Dell (Rice University), NASA

Jan. 23rd
Star Formation

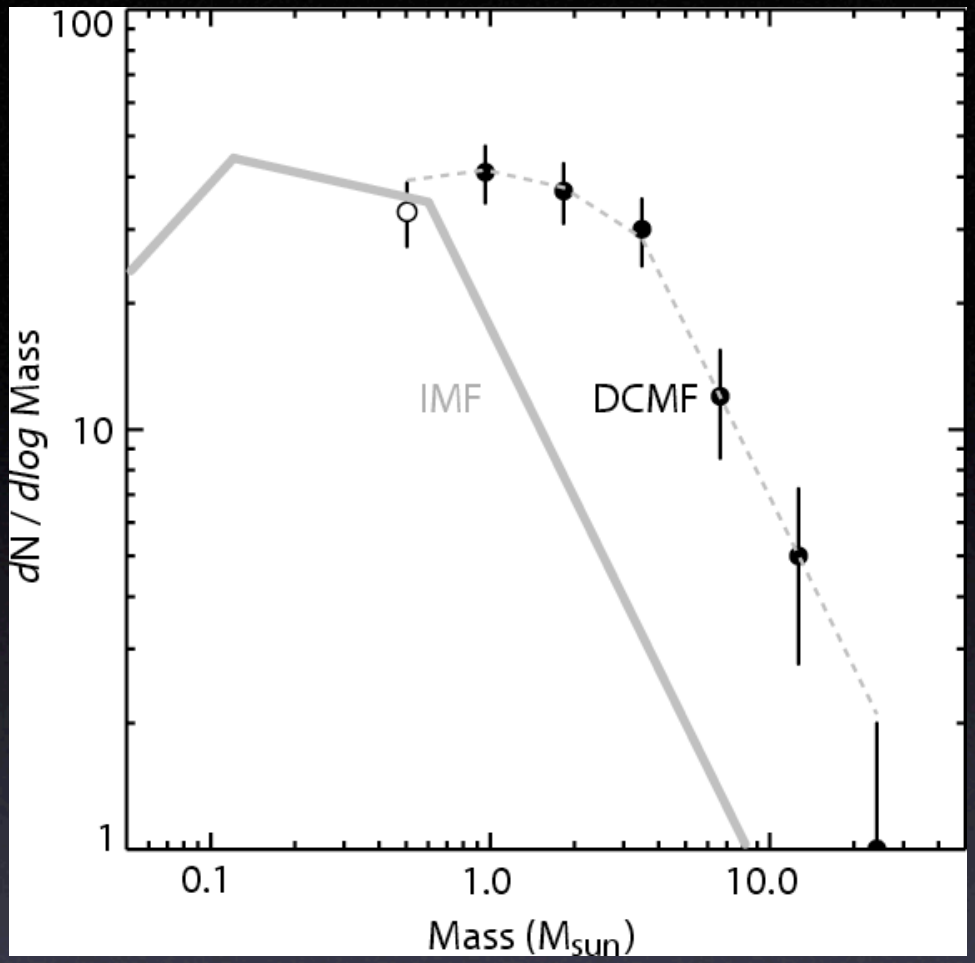
Homologous collapse of molecular cloud
Carroll & Ostlie, Fig. 12.8



Cloud cores in Pipe Nebula (near-IR extinction map) Alves+07

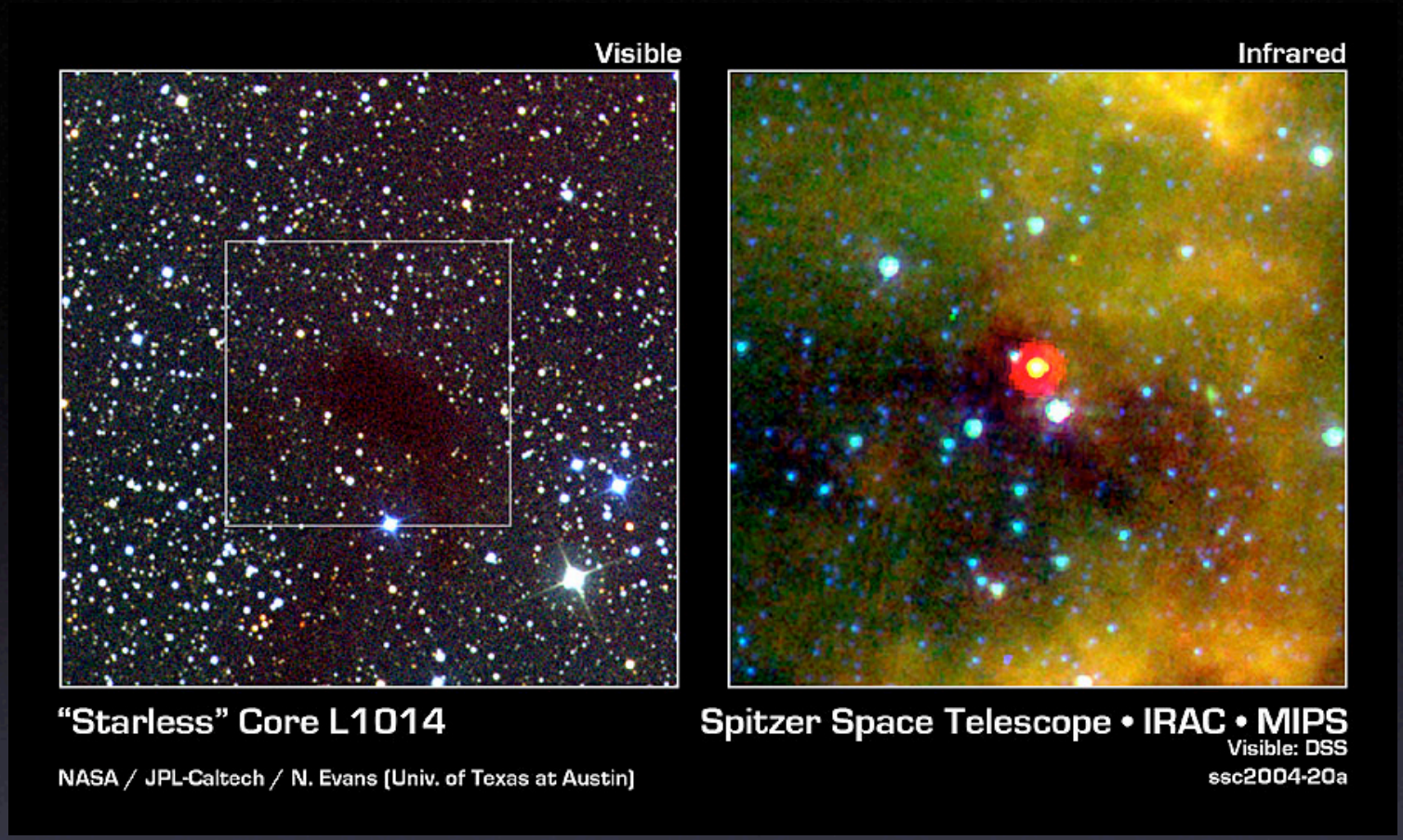


IMF of Orion
vs. dense core mass function
Alves+07



“Proplyds” in HII regions

Orion, HST


Visible
Infrared
"Starless" Core L1014
Spitzer Space Telescope • IRAC • MIPS
Visible: DSS
ssc2004-20a
NASA / JPL-Caltech / N. Evans (Univ. of Texas at Austin)

optical

Herbig-Haro objects

BHR71

Spitzer IR

Jets from young stars, still accreting

HH47, Spitzer IR

HST