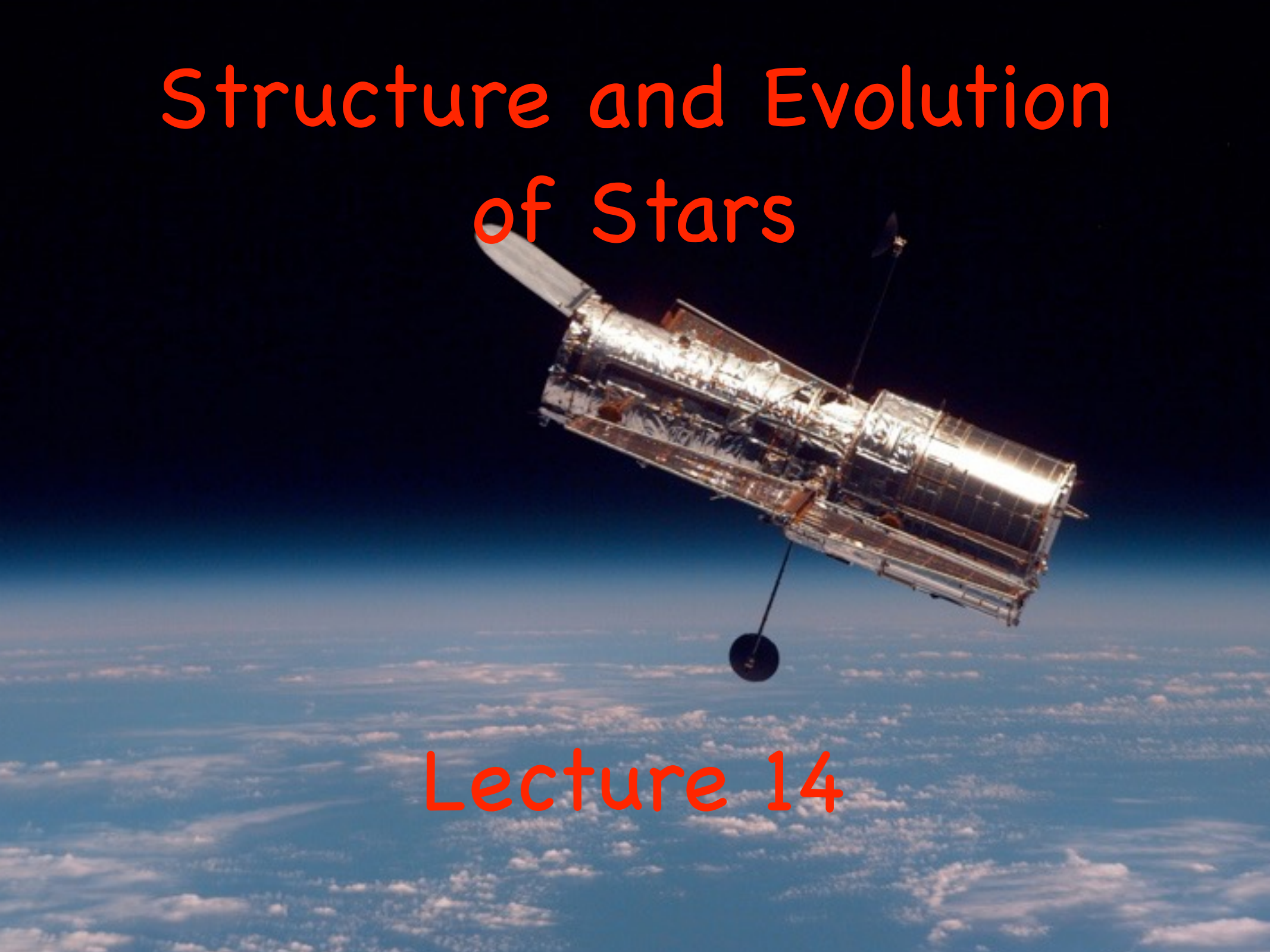
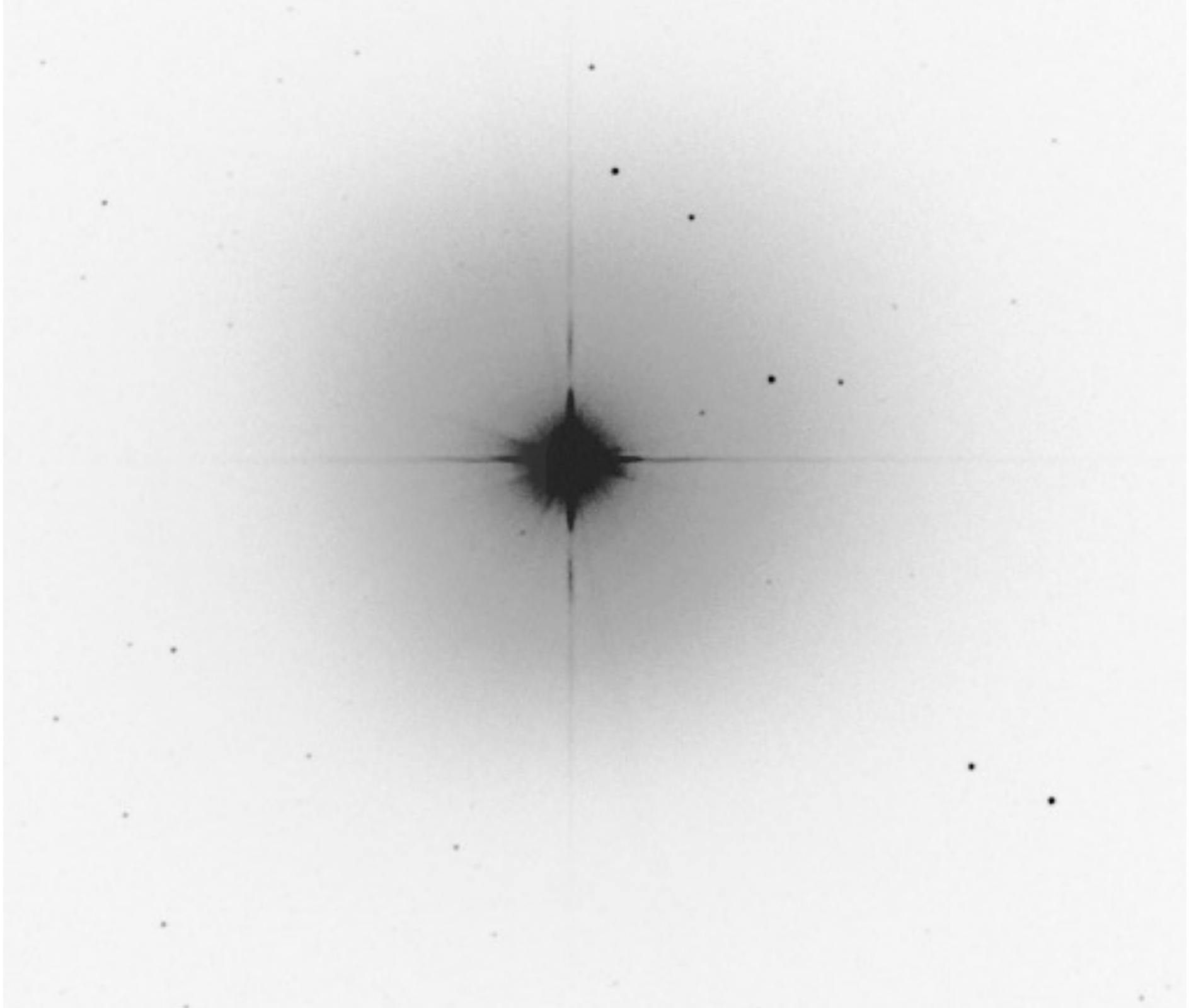
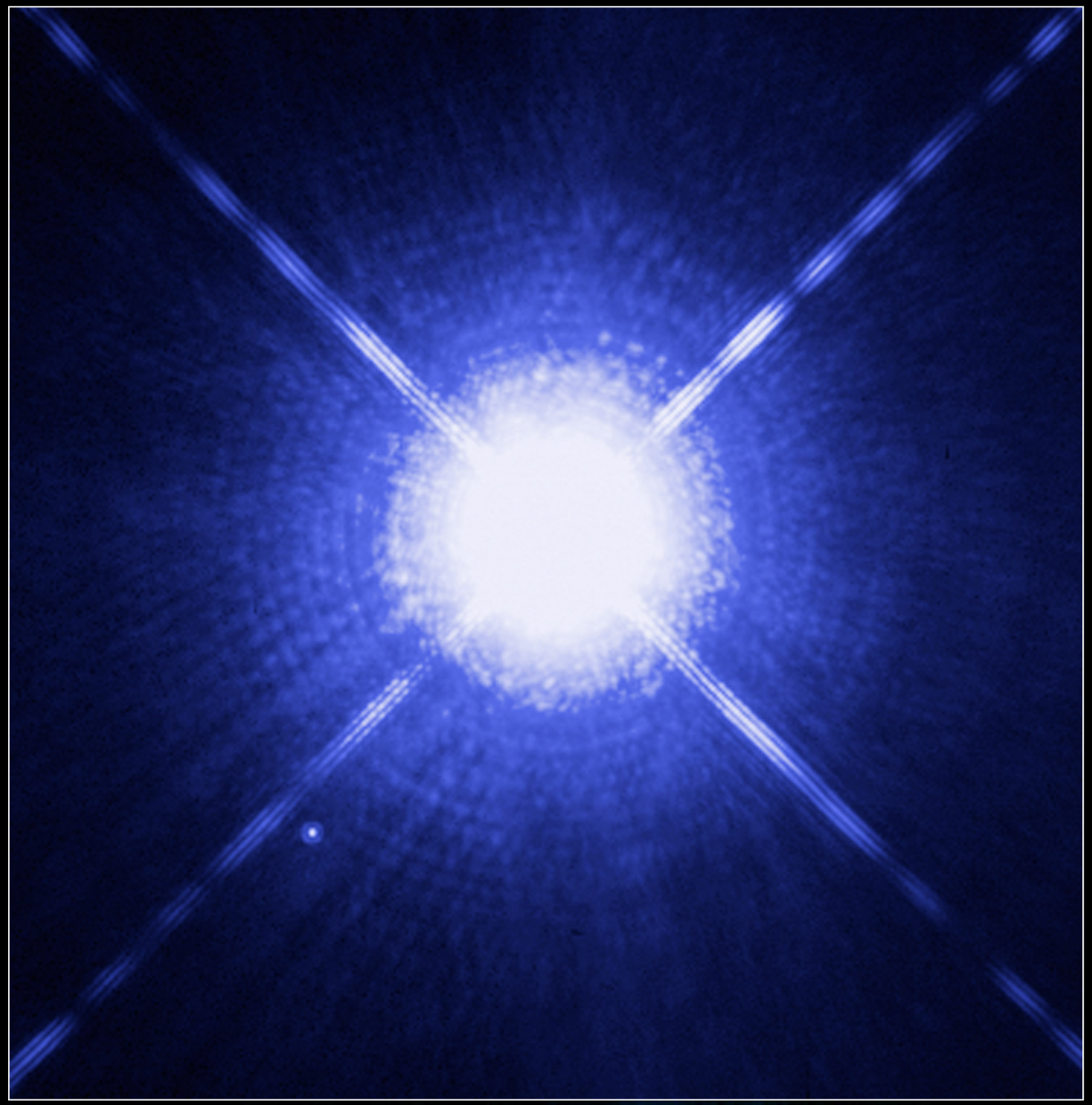
Structure and Evolution of Stars



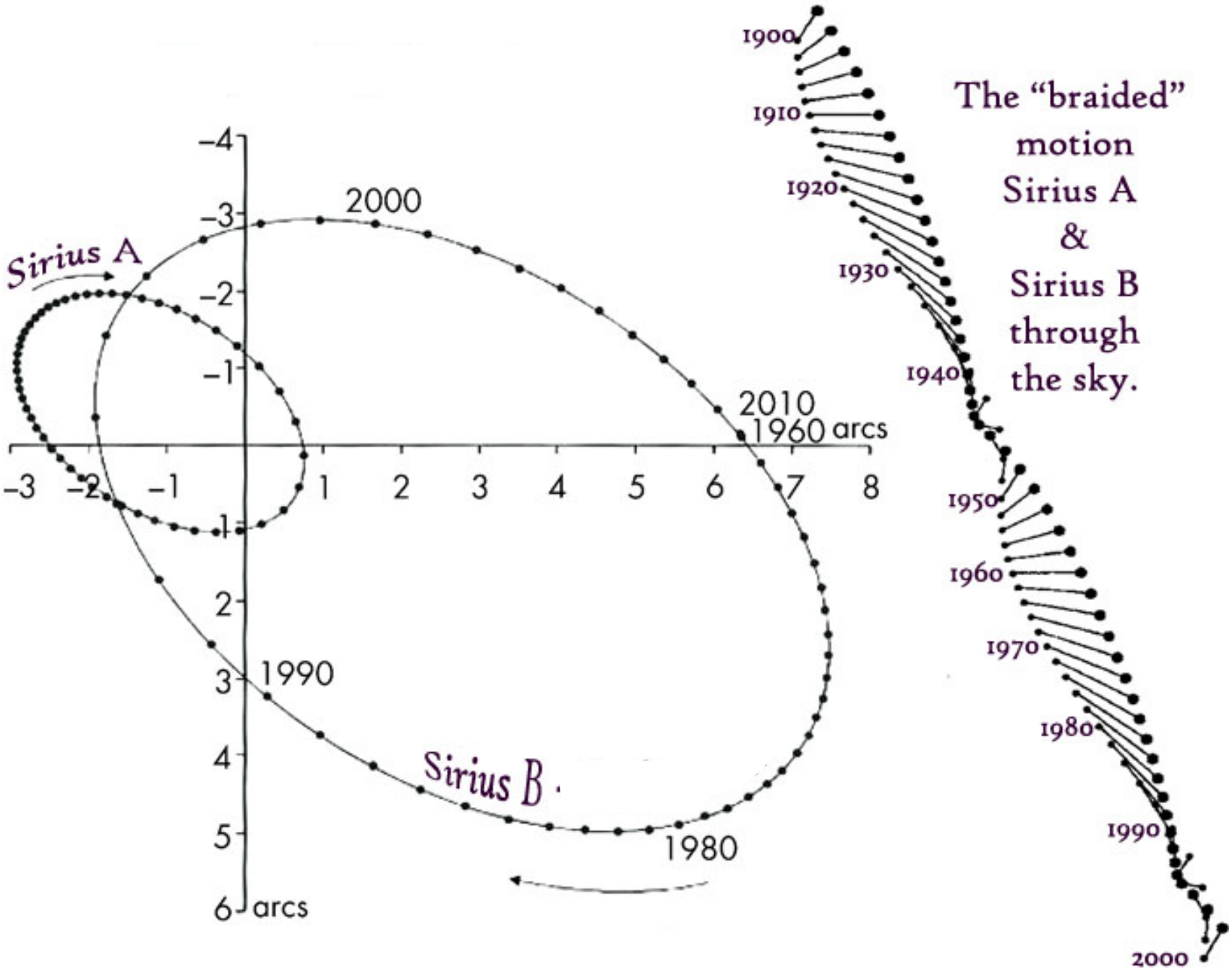
Lecture 14





Sirius A and Sirius B
Hubble Space Telescope • WFPC2

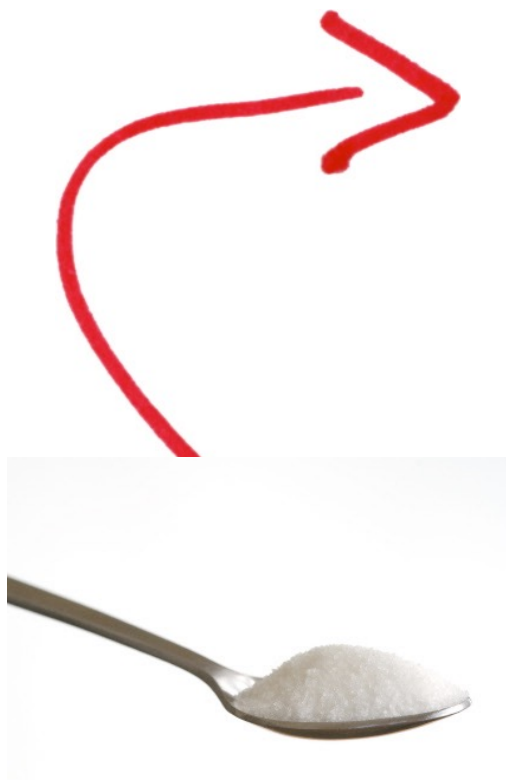
NASA, ESA, H. Bond (STScI), and M. Barstow (University of Leicester) STScI-PRC05-36a



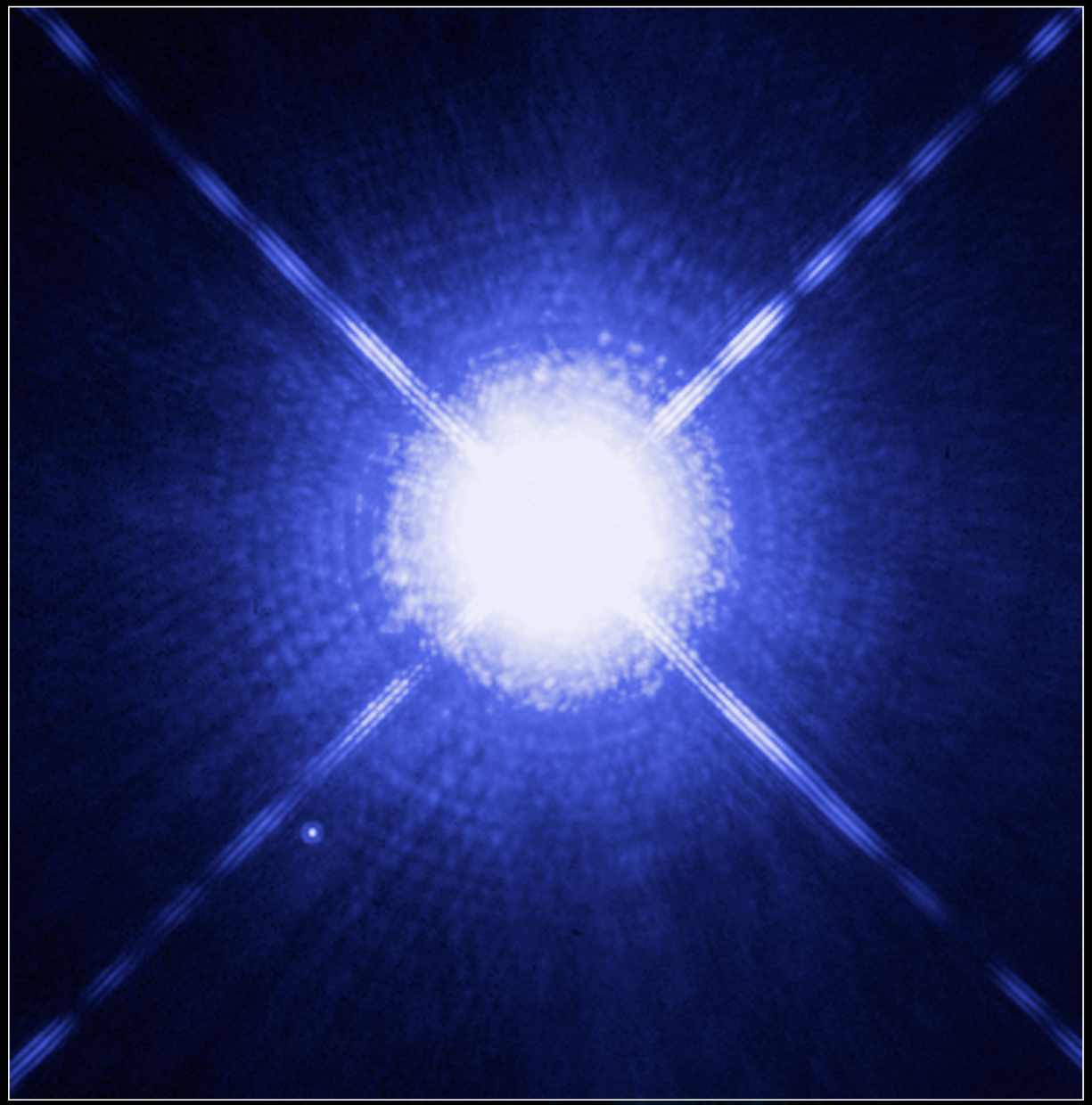
The "braided" motion Sirius A & Sirius B through the sky.

Table 14.1 Physical Parameters of the Sirius A B Binary System.

Property	Sirius A	Sirius B
Spectral type	A1V	DA2
M_V (mag)	1.4	11.2
Mass ($M_\odot$)	2.0	0.98
Radius ($R_\odot$)	1.7	0.0084
Surface gravity ($\log g$)	4.3	8.57
Luminosity ($L_\odot$)	25	0.026
Temperature (K)	9940	25 200

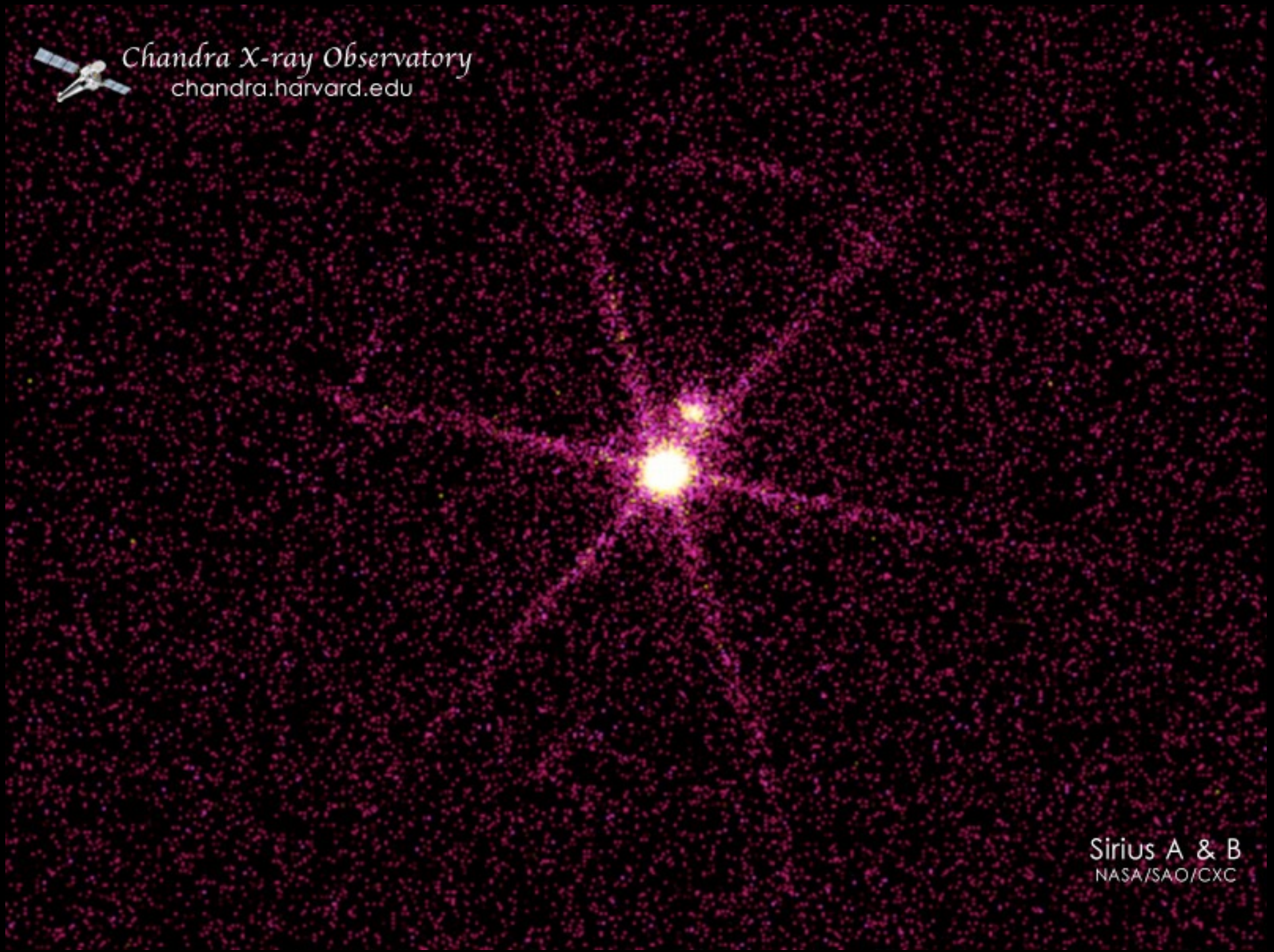


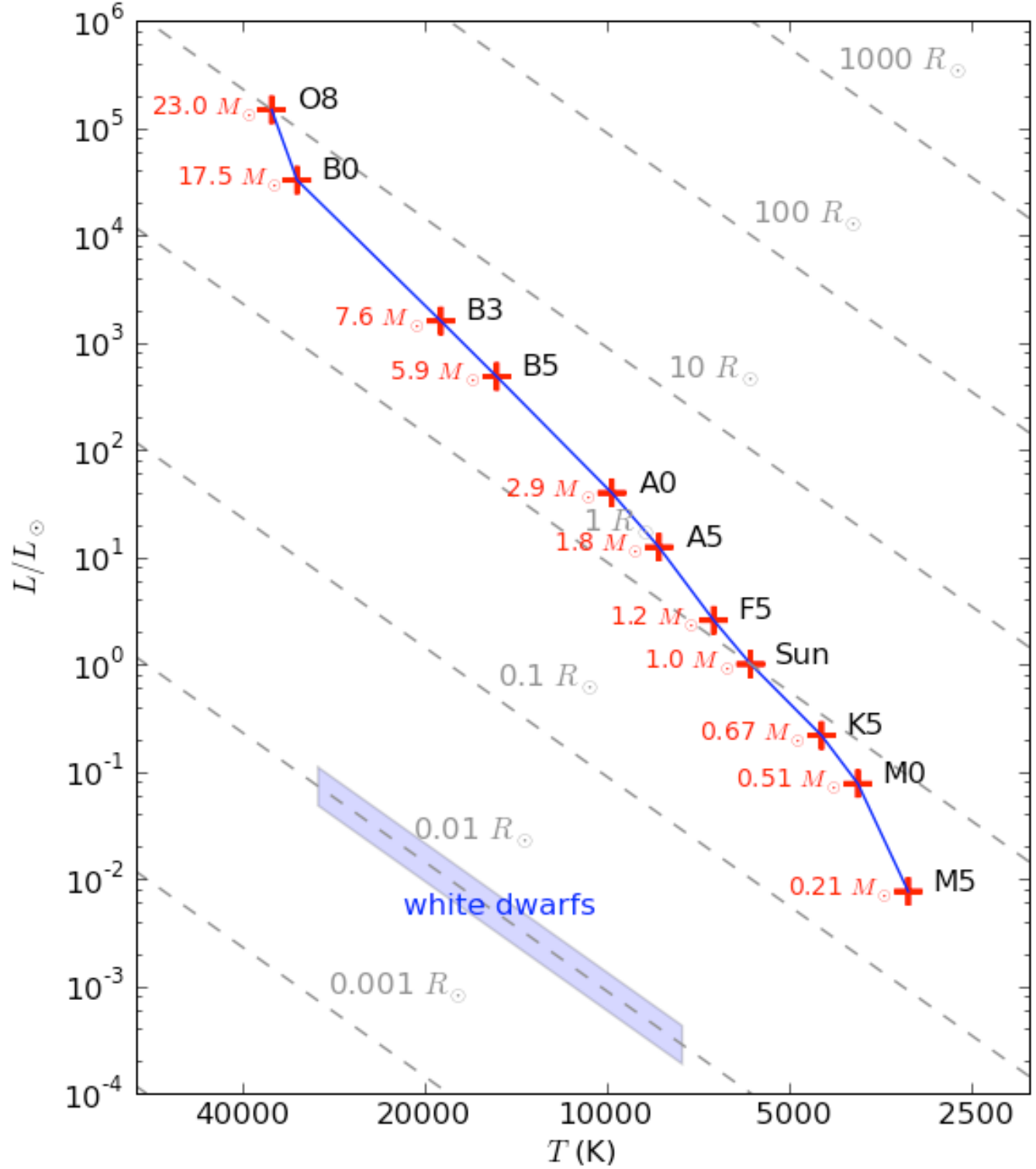

HYUNDAI
GOLD
16 TON

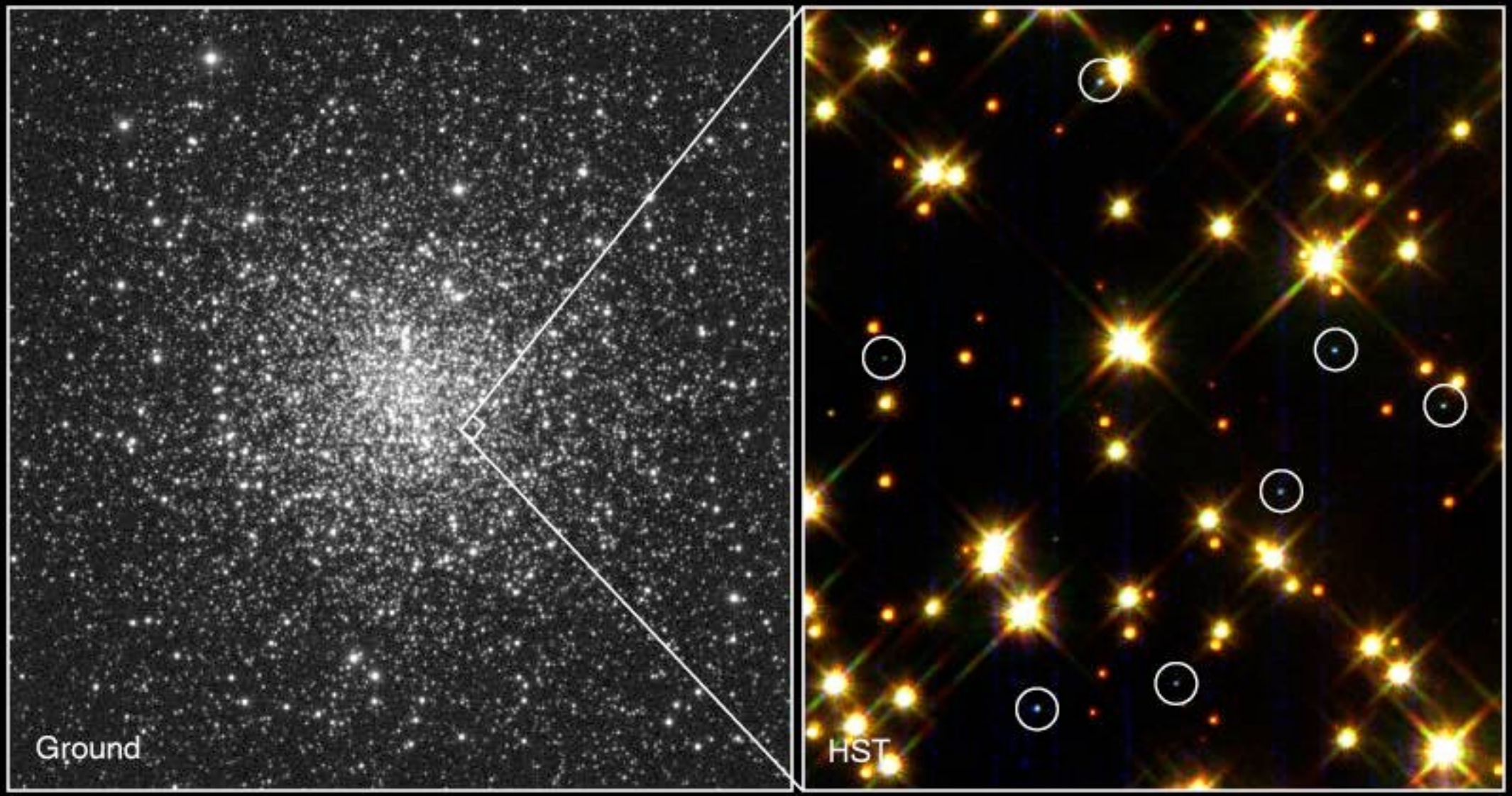


Sirius A and Sirius B
Hubble Space Telescope • WFPC2

NASA, ESA, H. Bond (STScI), and M. Barstow (University of Leicester) STScI-PRC05-36a


Chandra X-ray Observatory
chandra.harvard.edu
Sirius A & B
NASA/SAO/CXC

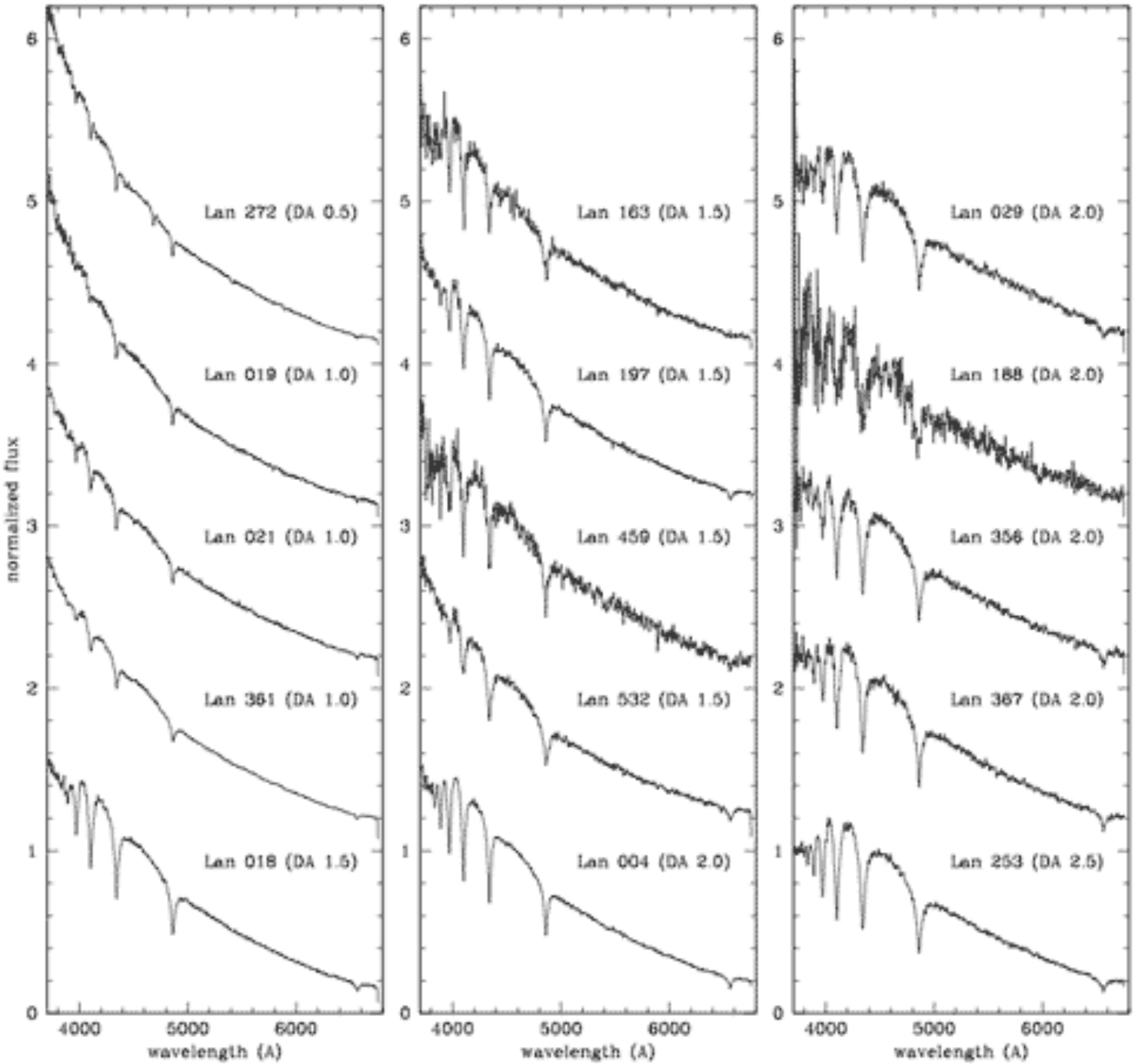

10^6
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
$L/L_\odot$
40000
20000
10000
5000
2500
T (K)
1000 $R_\odot$
100 $R_\odot$
10 $R_\odot$
1 $R_\odot$
0.1 $R_\odot$
0.01 $R_\odot$
0.001 $R_\odot$
23.0 $M_\odot$
O8
17.5 $M_\odot$
B0
7.6 $M_\odot$
B3
5.9 $M_\odot$
B5
2.9 $M_\odot$
A0
1.8 $M_\odot$
A5
1.2 $M_\odot$
F5
1.0 $M_\odot$
Sun
0.67 $M_\odot$
K5
0.51 $M_\odot$
M0
0.21 $M_\odot$
M5
white dwarfs

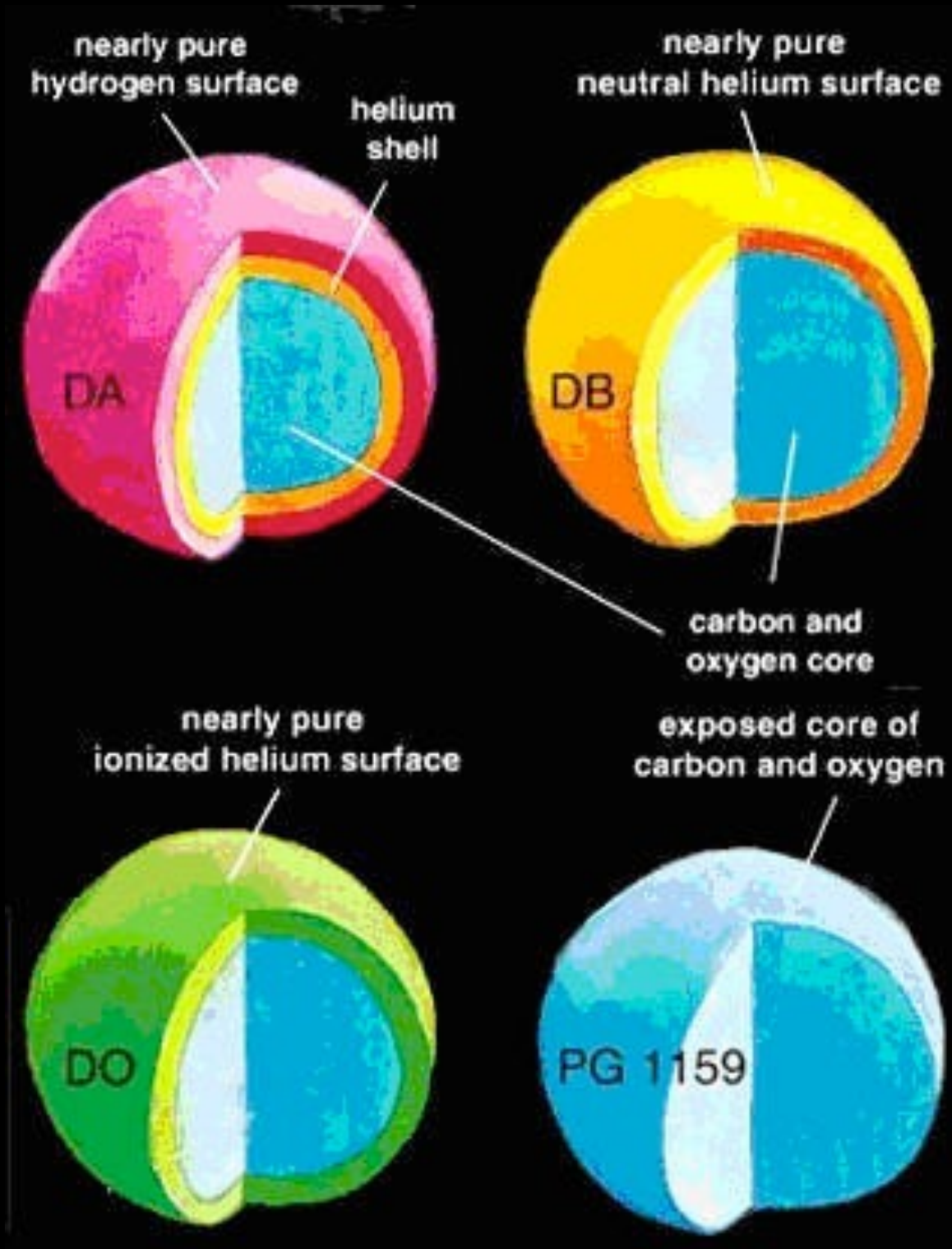


White Dwarf Stars in M4

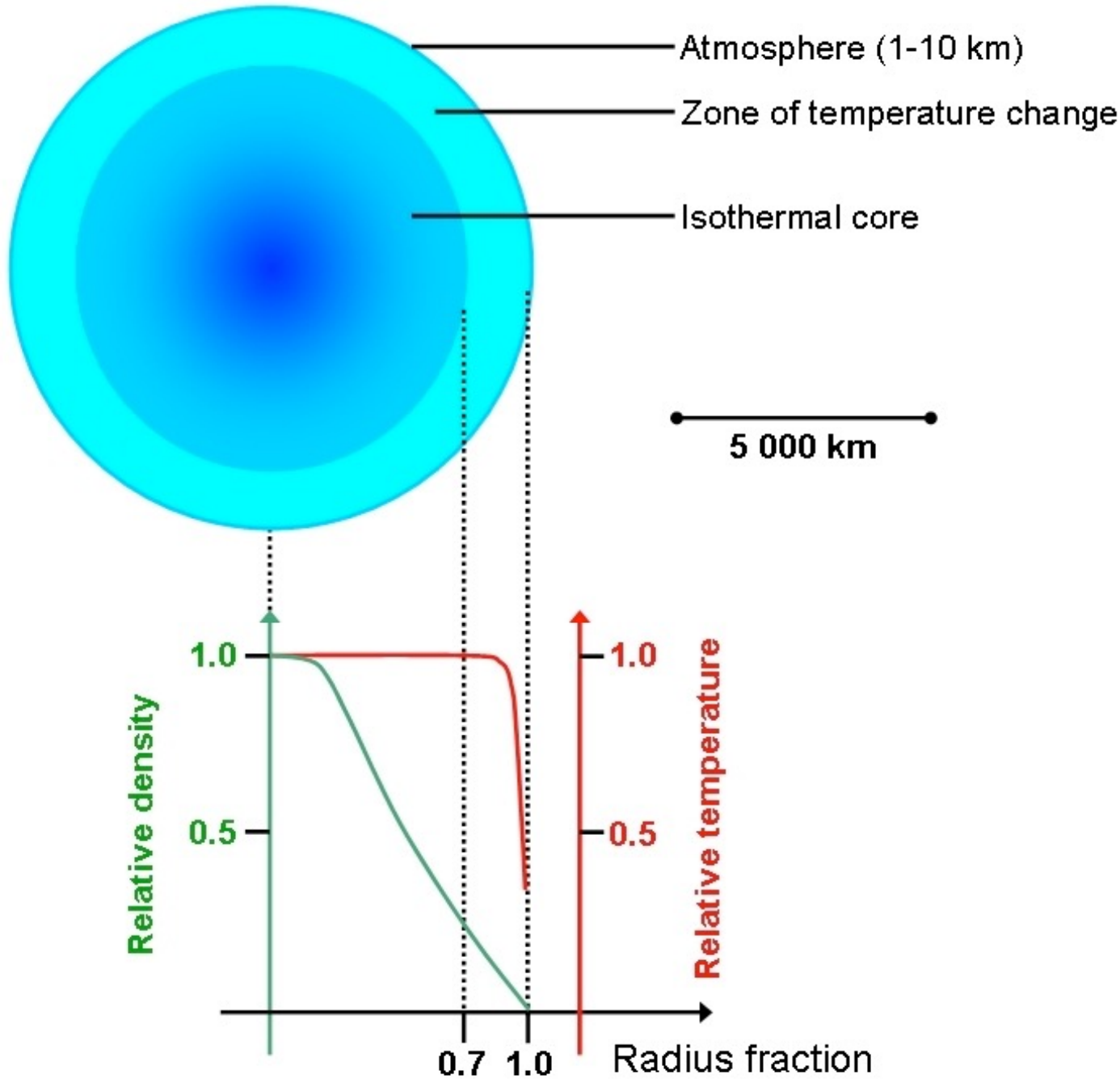
HST • WFPC2

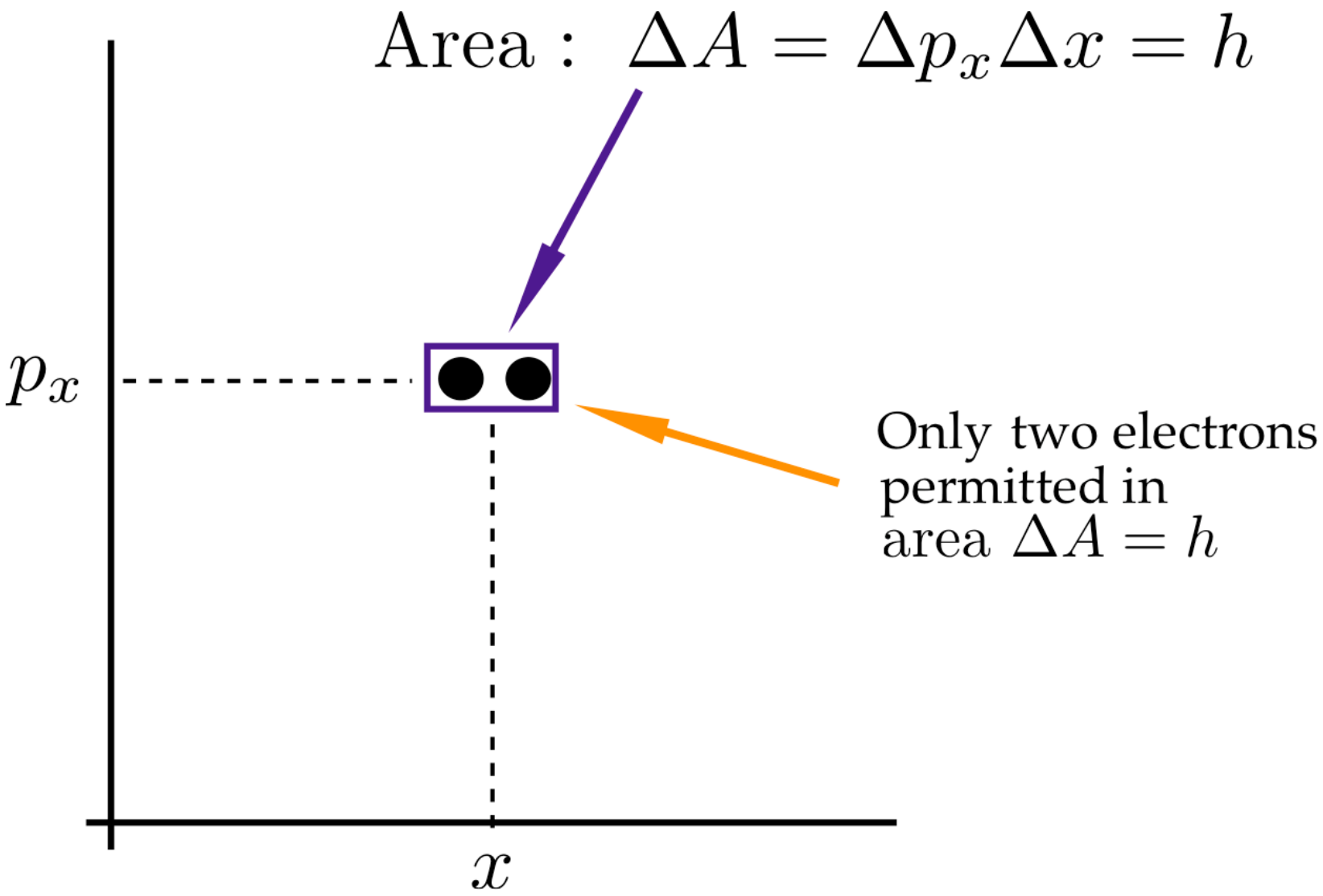
PRC95-32 · ST ScI OPO · August 28, 1995 · H. Bond (ST ScI), NASA

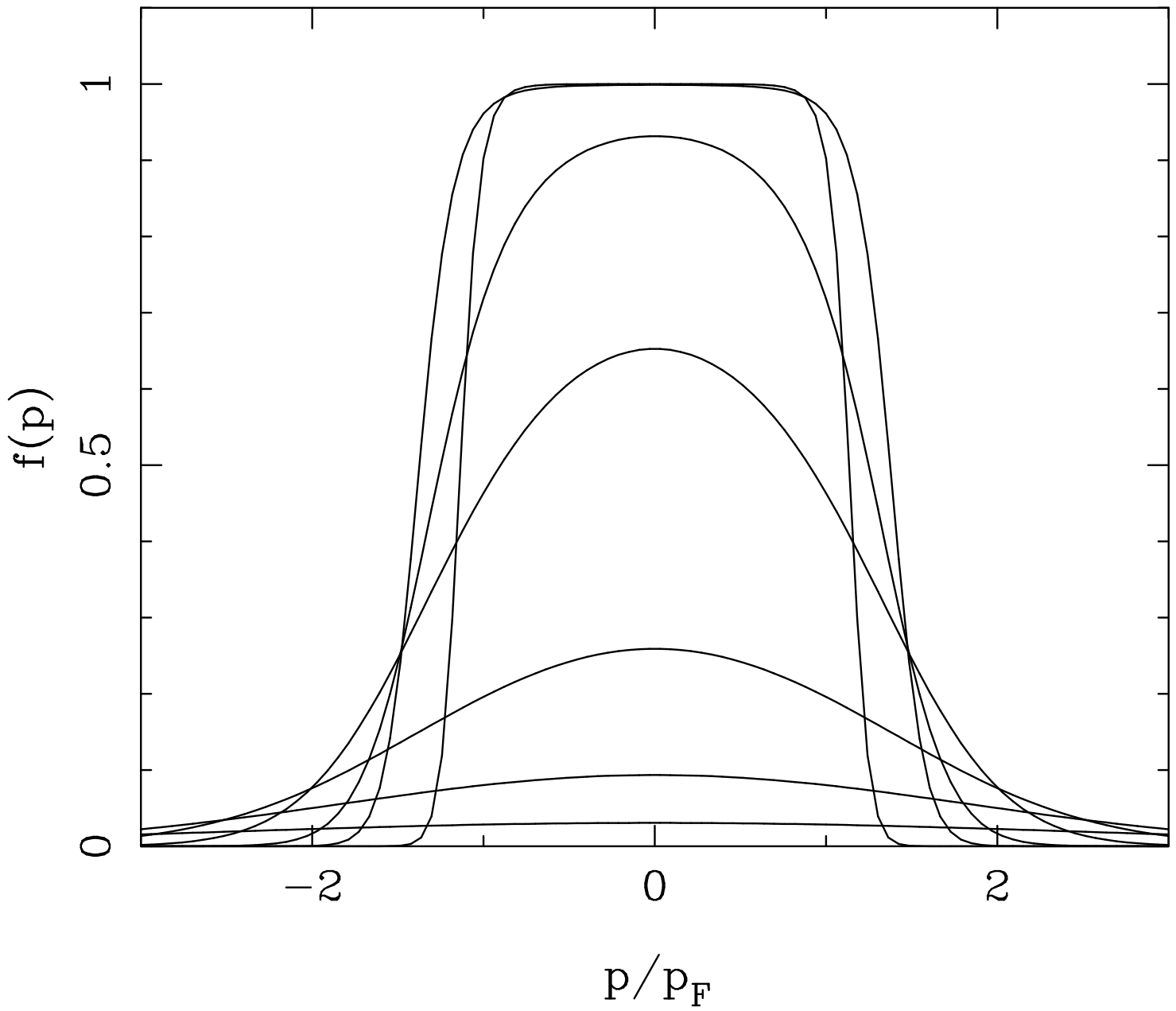

normalized flux
wavelength (A)
Lan 272 (DA 0.5)
Lan 019 (DA 1.0)
Lan 021 (DA 1.0)
Lan 361 (DA 1.0)
Lan 018 (DA 1.5)
Lan 163 (DA 1.5)
Lan 197 (DA 1.5)
Lan 459 (DA 1.5)
Lan 532 (DA 1.5)
Lan 004 (DA 2.0)
Lan 029 (DA 2.0)
Lan 188 (DA 2.0)
Lan 356 (DA 2.0)
Lan 367 (DA 2.0)
Lan 253 (DA 2.5)

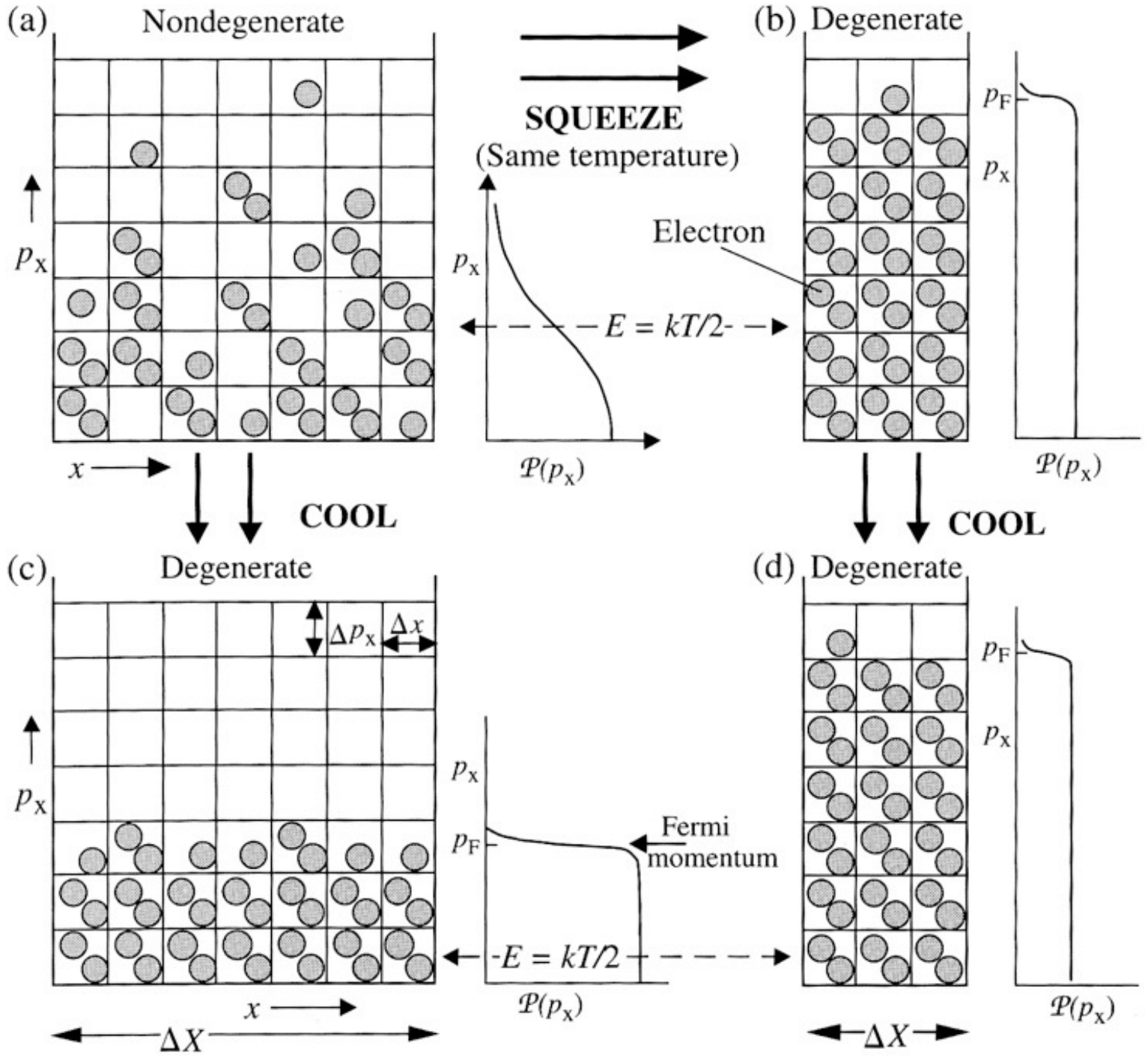

nearly pure
hydrogen surface
helium
shell
nearly pure
neutral helium surface
DA
DB
carbon and
oxygen core
nearly pure
ionized helium surface
exposed core of
carbon and oxygen
DO
PG 1159

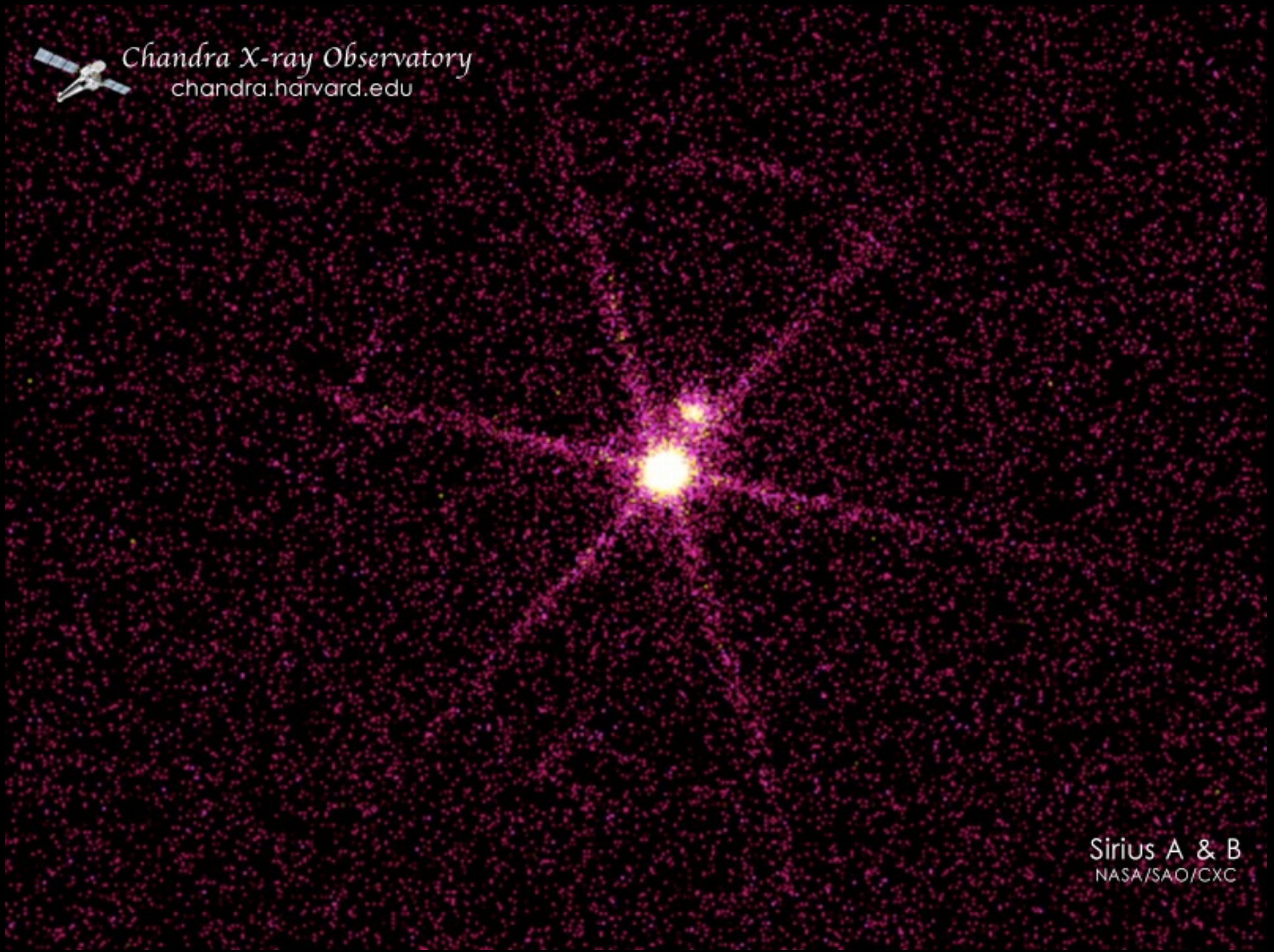
Structure of a White Dwarf

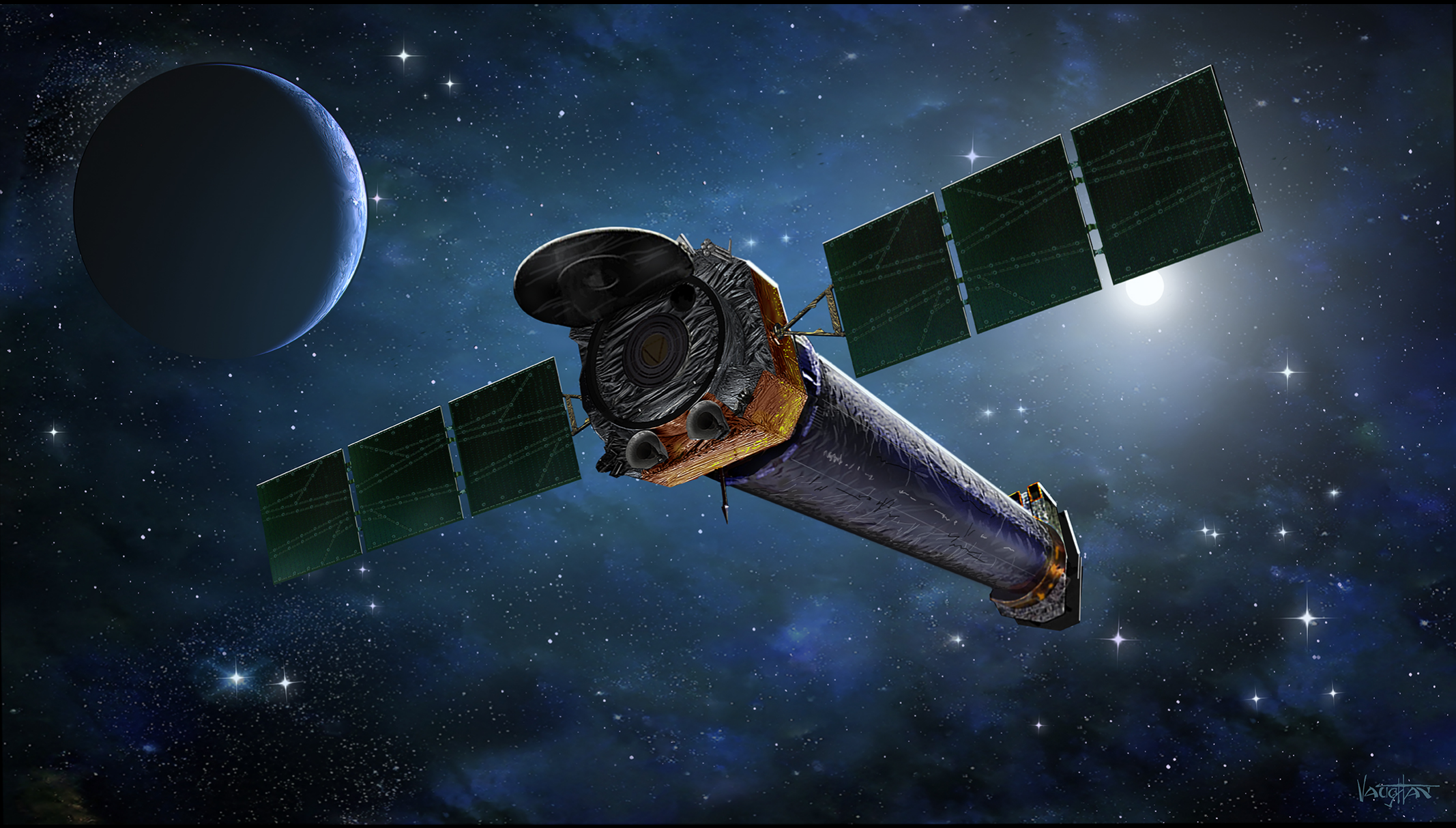



Area : $\Delta A = \Delta p_x \Delta x = h$
p_x
x
Only two electrons permitted in area $\Delta A = h$

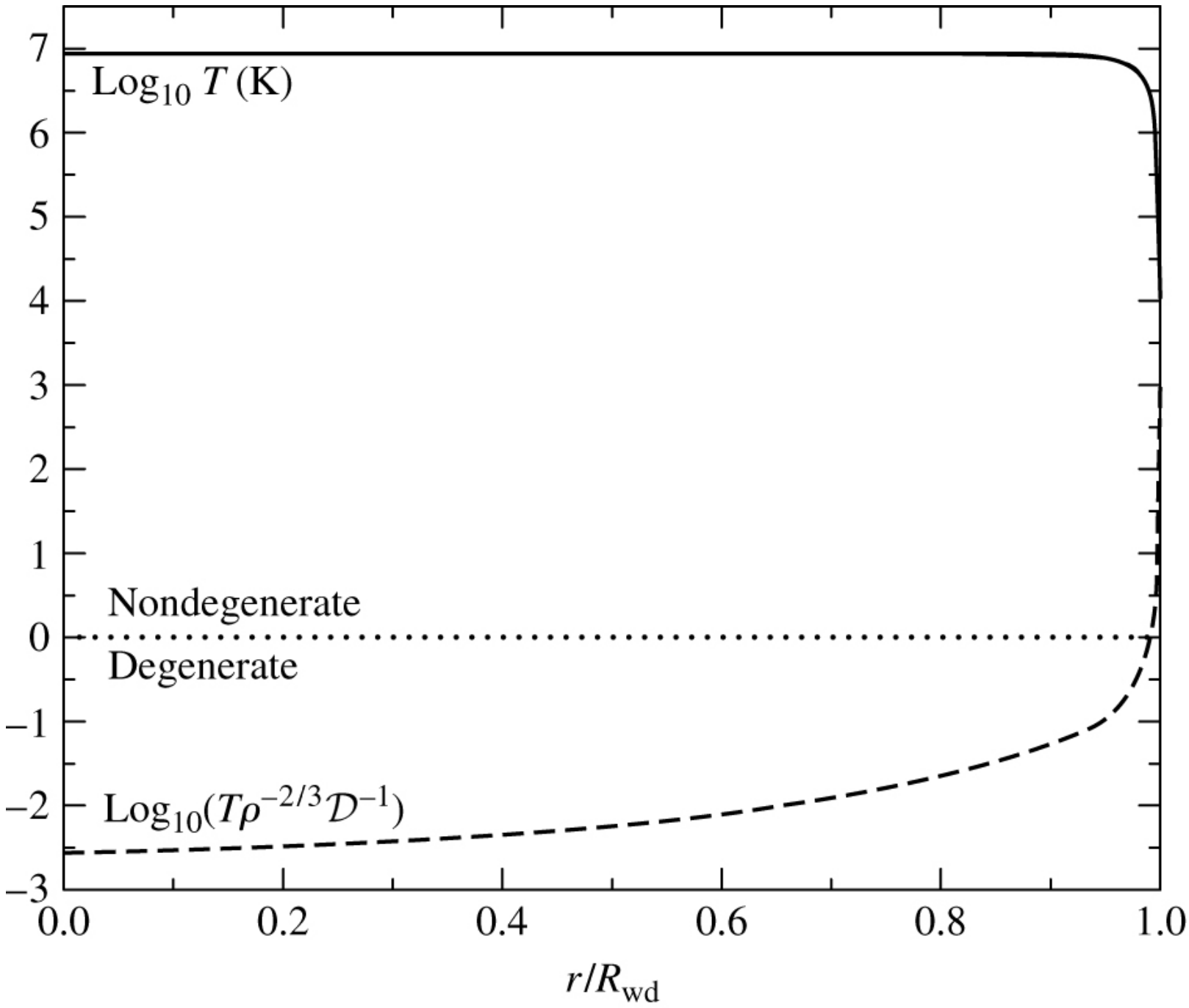

f(p)
1
0.5
0
−2
0
2
p/p_F

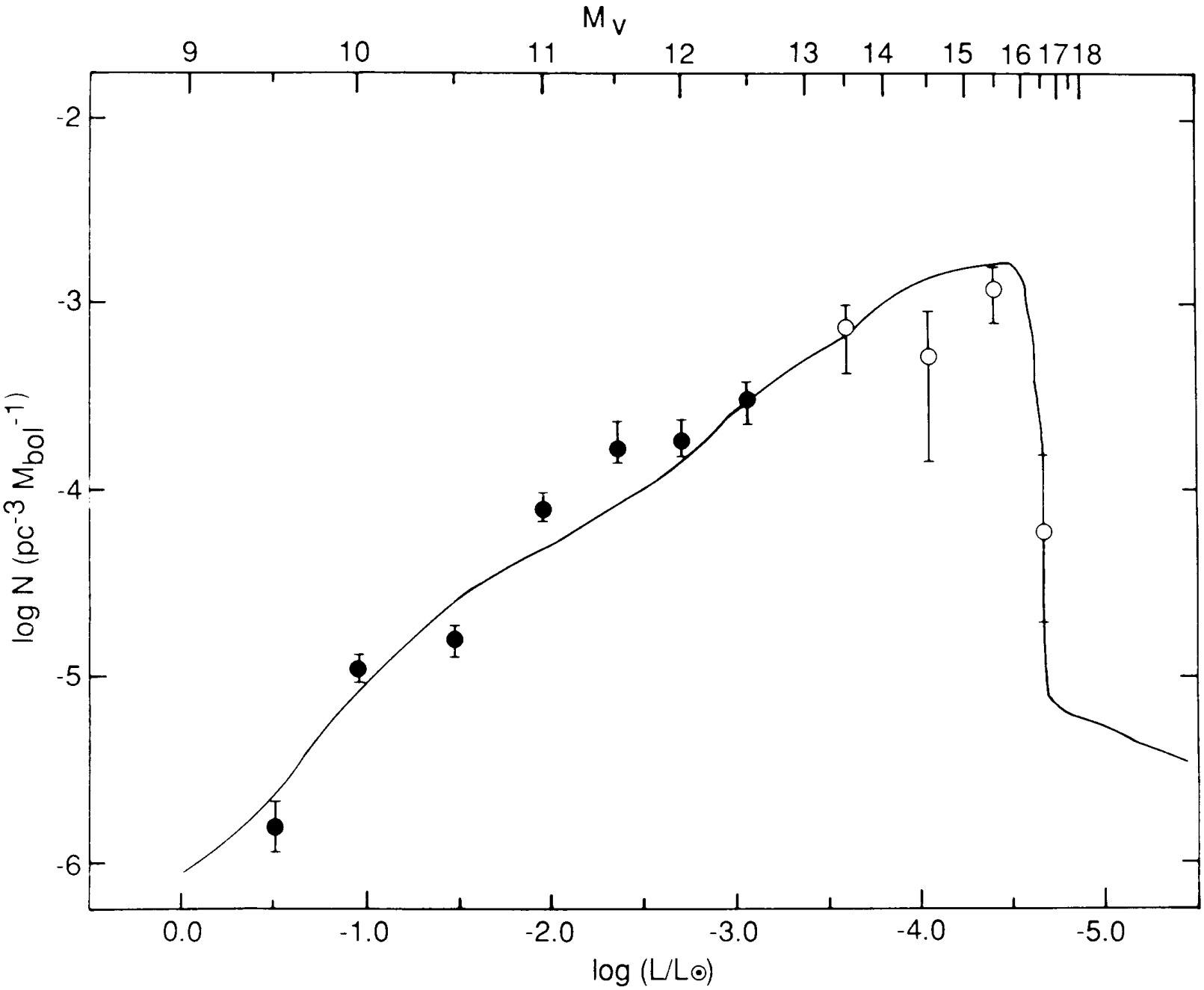

(a) Nondegenerate
(b) Degenerate
SQUEEZE
(Same temperature)
Electron
p_x
x
$E = kT/2$
$\mathcal{P}(p_x)$
p_F
COOL
COOL
(c) Degenerate
(d) Degenerate
Δp_x
Δx
Fermi momentum
$-E = kT/2$
ΔX


Chandra X-ray Observatory
chandra.harvard.edu
Sirius A & B
NASA/SAO/CXC


VAUGHAN


Sainsbury's
Argos
Sainsbury's Bank


7
6
5
4
3
2
1
0
−1
−2
−3
Log10 T (K)
Nondegenerate
Degenerate
Log10(Tρ−2/3D−1)
0.0
0.2
0.4
0.6
0.8
1.0
r/Rwd



Winget et al. 1987

The Cosmic Microwave Background as seen by Planck and WMAP