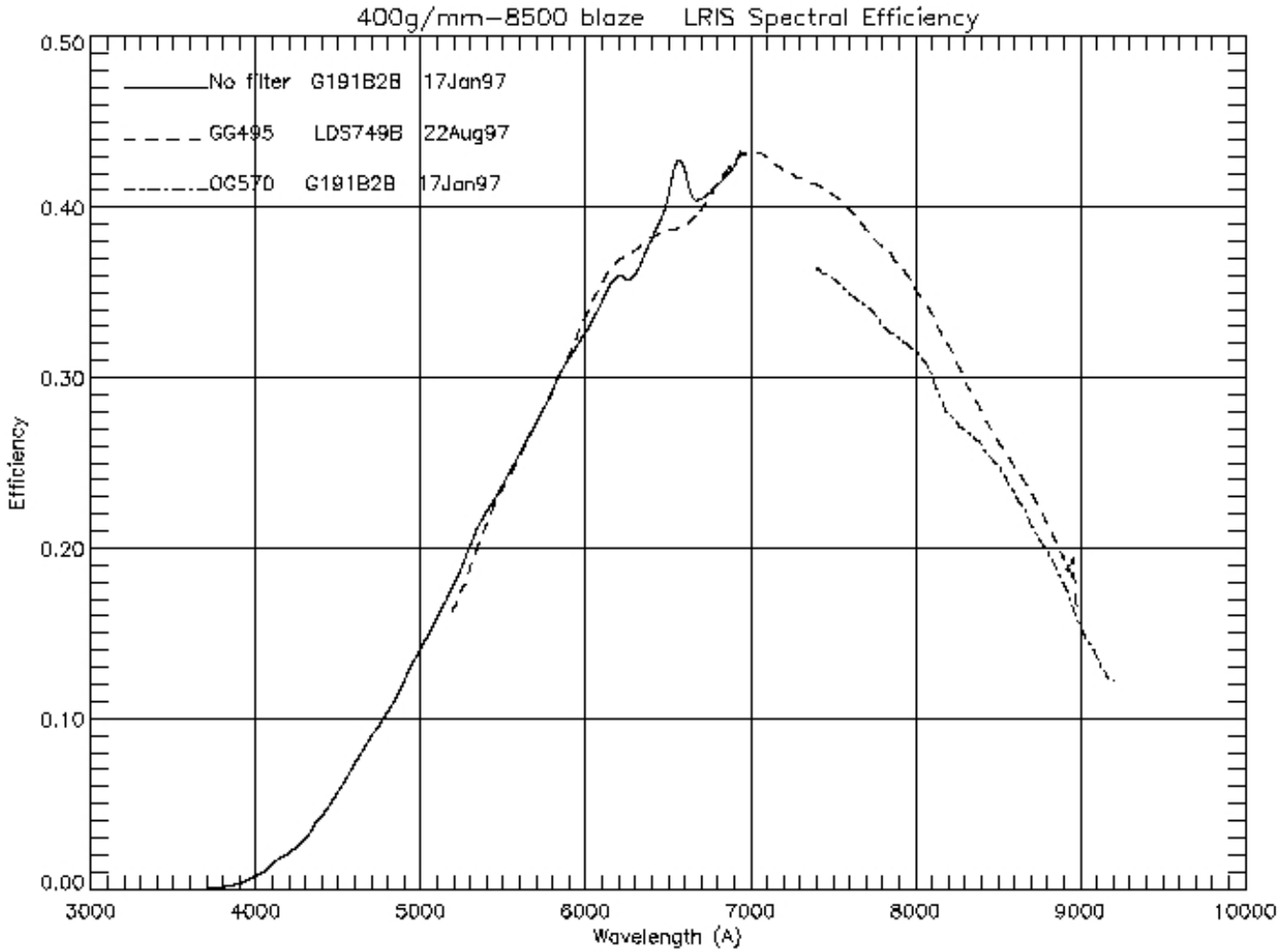
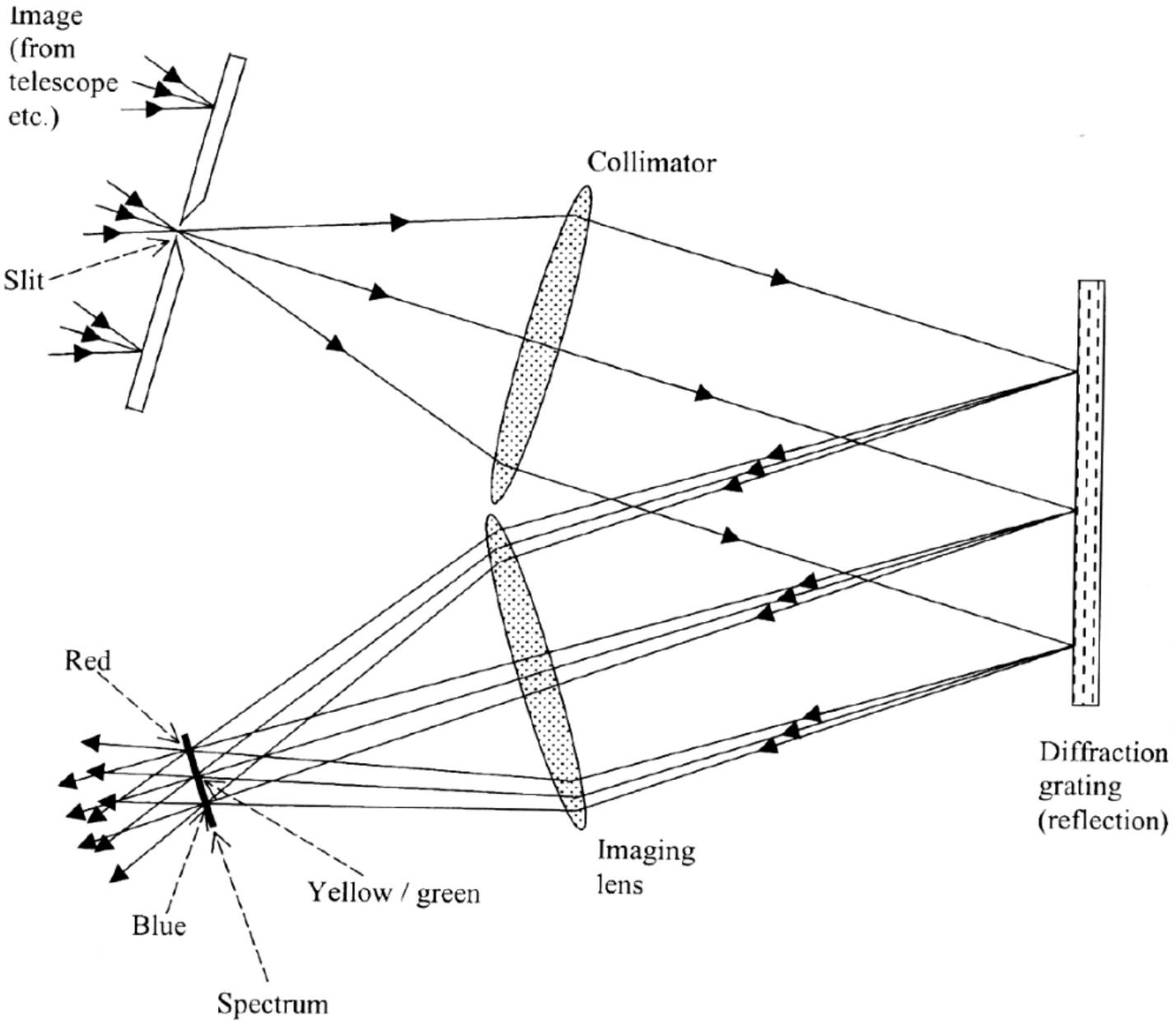
Solar and stellar spectra

Ay 20, Fall 2019, Lectures 12 and 13

Vikram Ravi

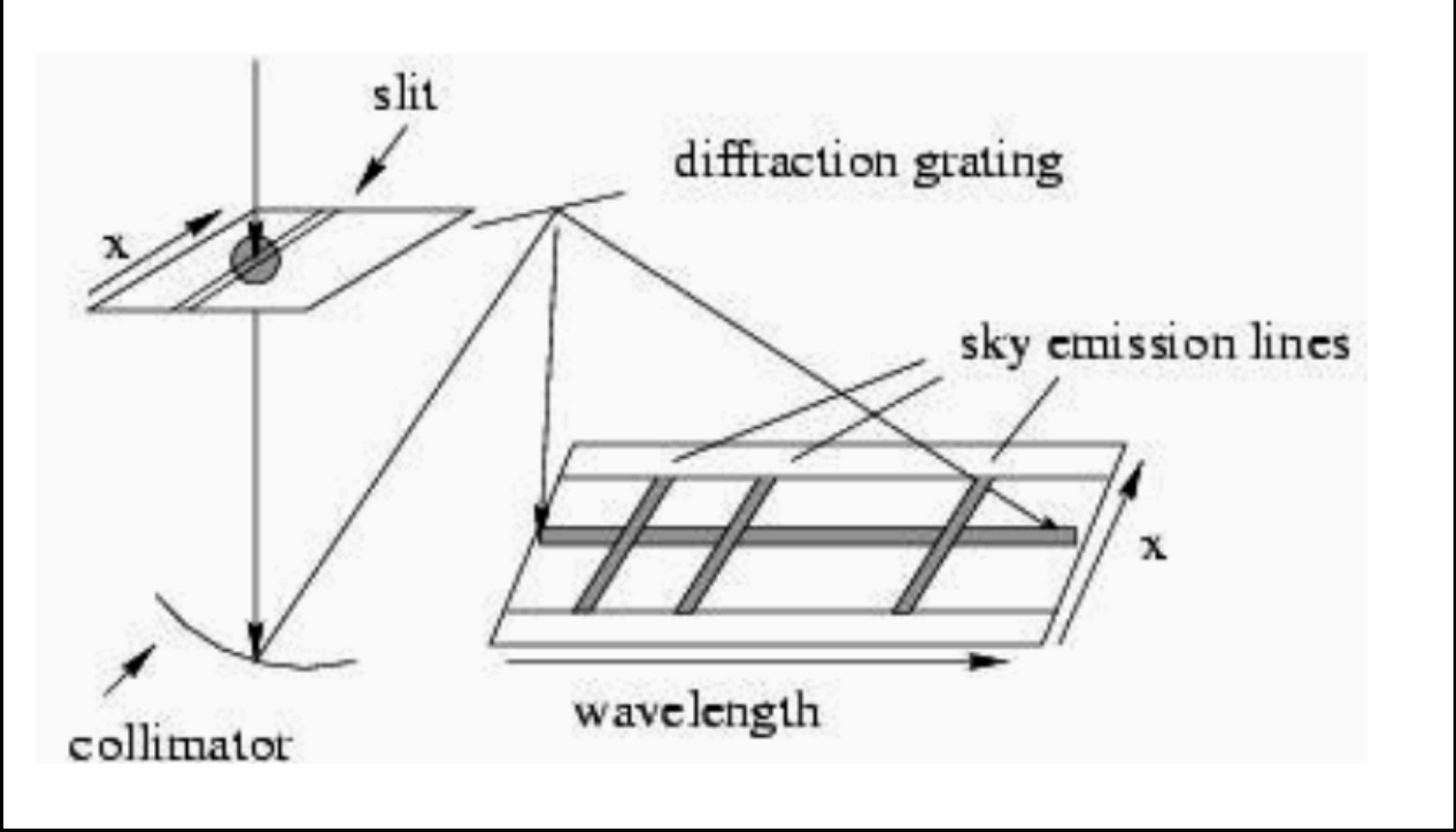

400g/mm–8500 blaze LRIS Spectral Efficiency
No filter G191B2B 17Jan97
GG495 LDS749B 22Aug97
OG570 G191B2B 17Jan97
Efficiency
0.50
0.40
0.30
0.20
0.10
0.00
3000
4000
5000
6000
7000
8000
9000
10000
Wavelength (A)

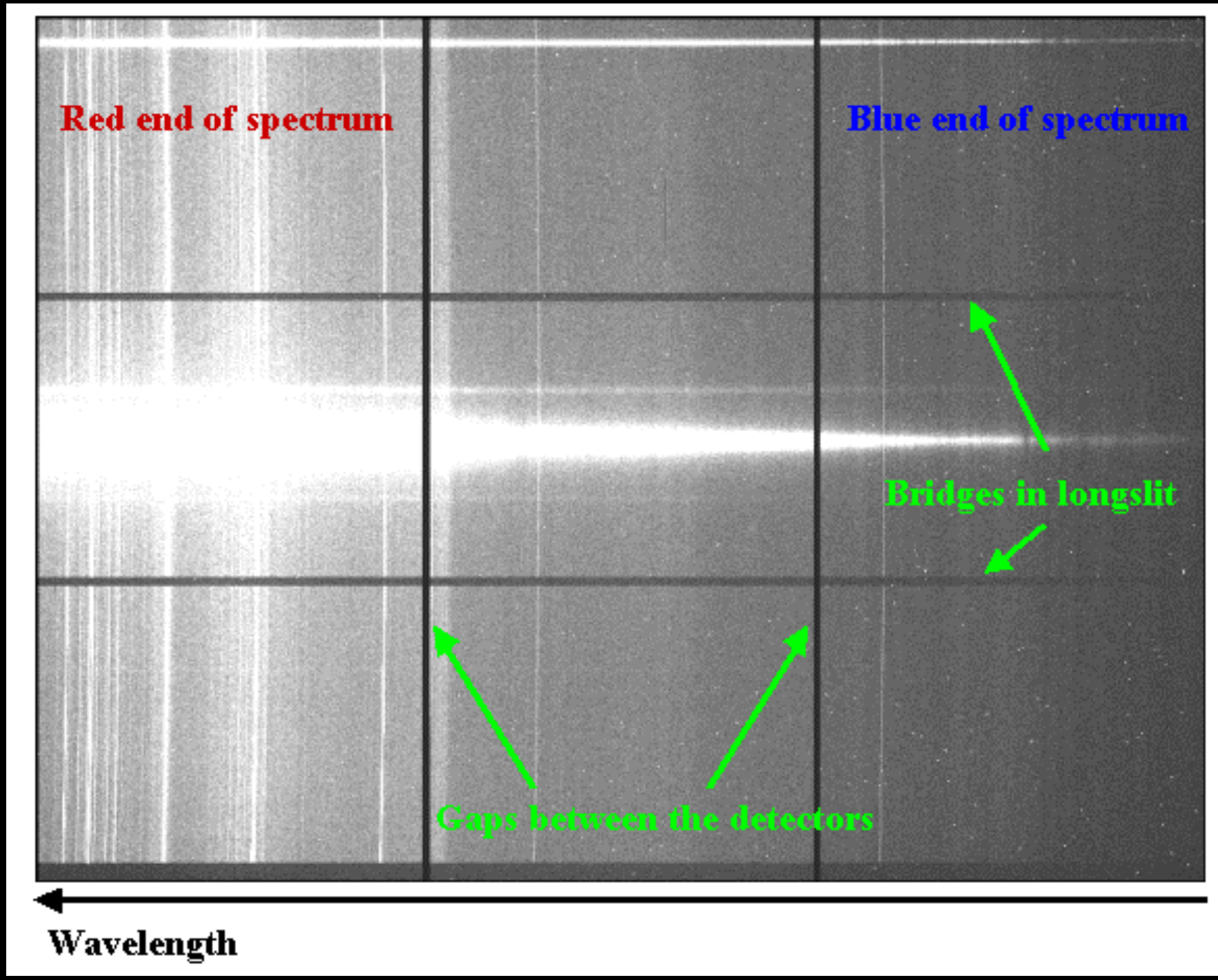
Difraction Grating Spectrograph

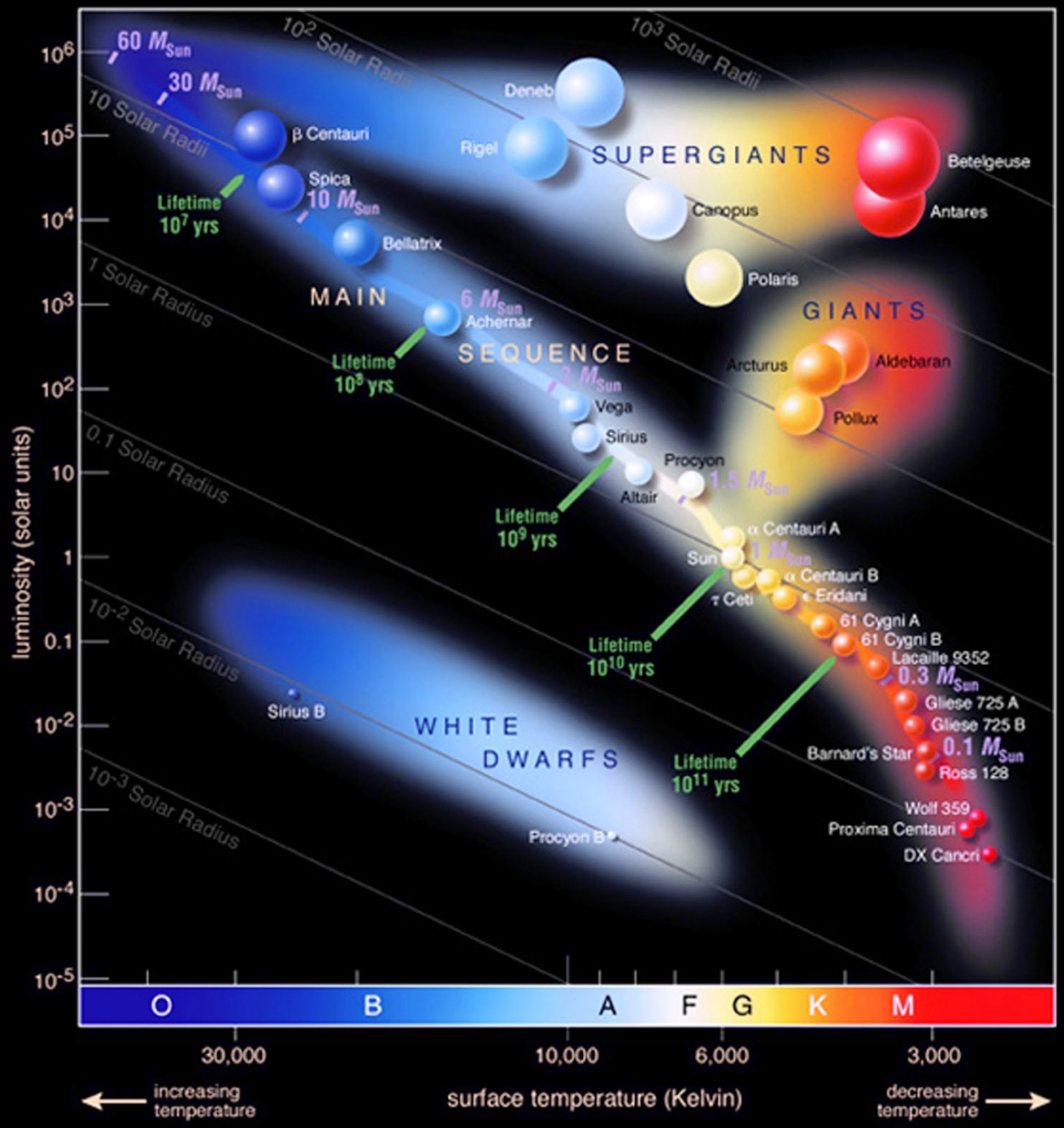


G. Djorgovski

Long-slit spectroscopy




Red end of spectrum
Blue end of spectrum
Bridges in longslit
Gaps between the detectors
Wavelength

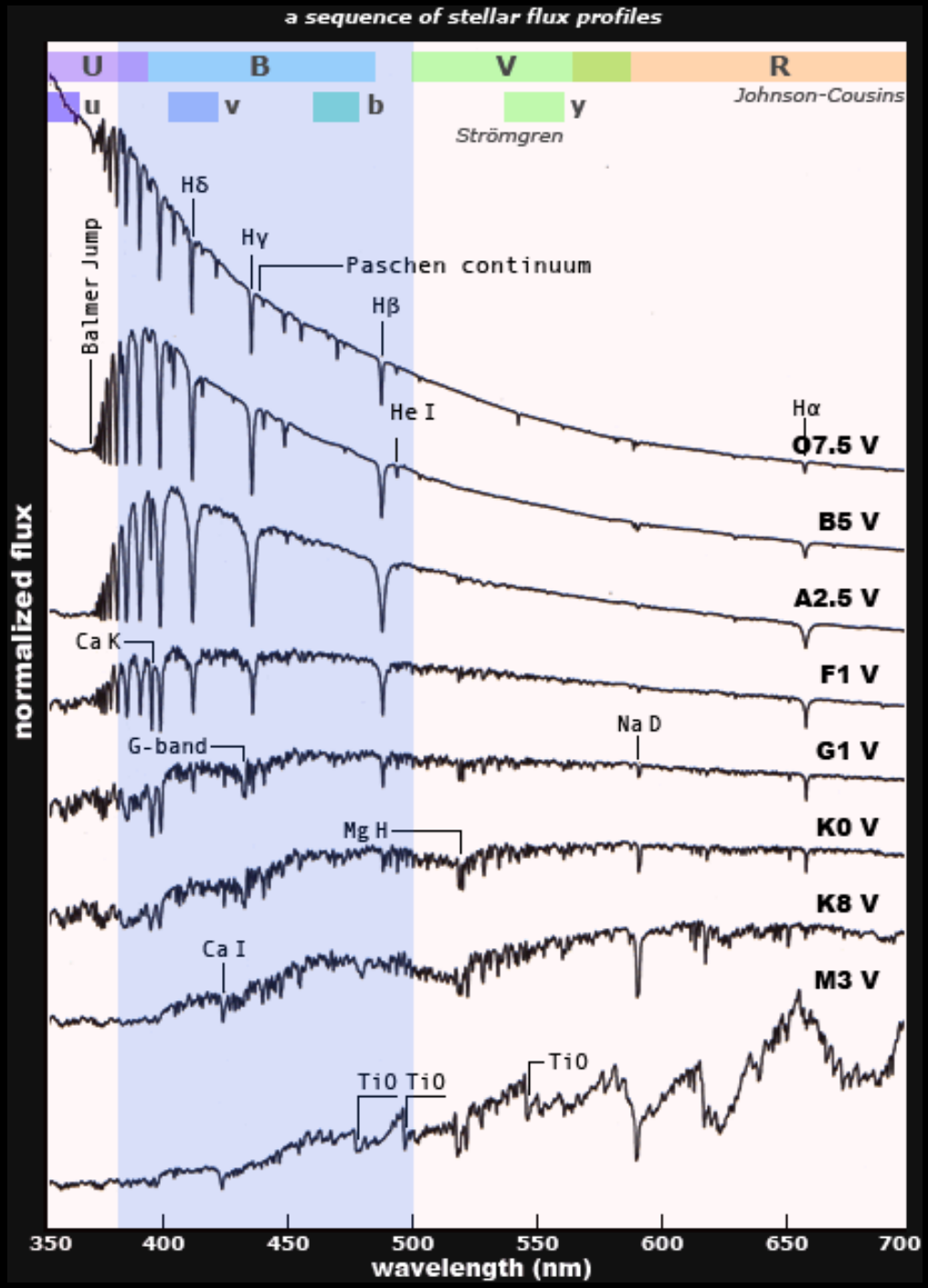

luminosity (solar units)
10^6
10^5
10^4
10^3
10^2
10
1
0.1
10^{-2}
10^{-3}
10^{-4}
10^{-5}
60 M_{Sun}
30 M_{Sun}
10 M_{Sun}
6 M_{Sun}
3 M_{Sun}
1.5 M_{Sun}
1 M_{Sun}
0.3 M_{Sun}
0.1 M_{Sun}
10^2 Solar Radii
10^3 Solar Radii
10 Solar Radii
1 Solar Radius
0.1 Solar Radius
10^{-2} Solar Radius
10^{-3} Solar Radius
Deneb
Rigel
SUPERGIANTS
Betelgeuse
Antares
Canopus
Polaris
β Centauri
Spica
Bellatrix
MAIN
SEQUENCE
Achernar
GIANTS
Arcturus
Aldebaran
Pollux
Vega
Sirius
Procyon
Altair
α Centauri A
Sun
α Centauri B
τ Ceti
ε Eridani
61 Cygni A
61 Cygni B
Lacaille 9352
Gliese 725 A
Gliese 725 B
Barnard's Star
Ross 128
Wolf 359
Proxima Centauri
DX Cancri
Sirius B
Procyon B
WHITE
DWARFS
Lifetime 10^7 yrs
Lifetime 10^8 yrs
Lifetime 10^9 yrs
Lifetime 10^{10} yrs
Lifetime 10^{11} yrs
O
B
A
F
G
K
M
30,000
10,000
6,000
3,000
increasing temperature
surface temperature (Kelvin)
decreasing temperature

WIkipedia

Type	Color	Approximate Surface Temperature	Main Characteristics	Examples
O		> 25,000 K	Singly ionized helium lines either in emission or absorption. Strong ultraviolet continuum.	10 Lacertra
B		11,000 - 25,000	Neutral helium lines in absorption.	Rigel Spica
A		7,500 - 11,000	Hydrogen lines at maximum strength for A0 stars, decreasing thereafter.	Sirius Vega
F		6,000 - 7,500	Metallic lines become noticeable.	Canopus Procyon
G		5,000 - 6,000	Solar-type spectra. Absorption lines of neutral metallic atoms and ions (e.g. once-ionized calcium) grow in strength.	Sun Capella
K		3,500 - 5,000	Metallic lines dominate. Weak blue continuum.	Arcturus Aldebaran
M		< 3,500	Molecular bands of titanium oxide noticeable.	Betelgeuse Antares

0 or Ia+	Hypergiants of extreme luminosity (or size)
Ia	Supergiants of high luminosity, Eta Canis Majoris (B5Ia)
Iab	Supergiants of intermediate luminosity, Gamma Cygni (F8Iab)
Ib	Supergiants of lower luminosity (or size), Zeta Persei (B1Ib)
II	bright Giants
III	"normal" Giants, Arcturus (K0III)
IV	Subgiants
V	Main Sequence stars or Dwarfs, the Sun (G2V)
sd prefix	Subdwarfs
D prefix	White Dwarfs

Harvard spectral classification scheme, and Morgan-Keenan luminosity classes


a sequence of stellar flux profiles
U
B
V
R
Johnson-Cousins
u
v
b
y
Strömgren
Hδ
Hγ
Paschen continuum
Hβ
Balmer Jump
He I
Hα
O7.5 V
B5 V
A2.5 V
Ca K
F1 V
Na D
G-band
G1 V
Mg H
K0 V
K8 V
Ca I
M3 V
TiO TiO
TiO
normalized flux
350
400
450
500
550
600
650
700
wavelength (nm)