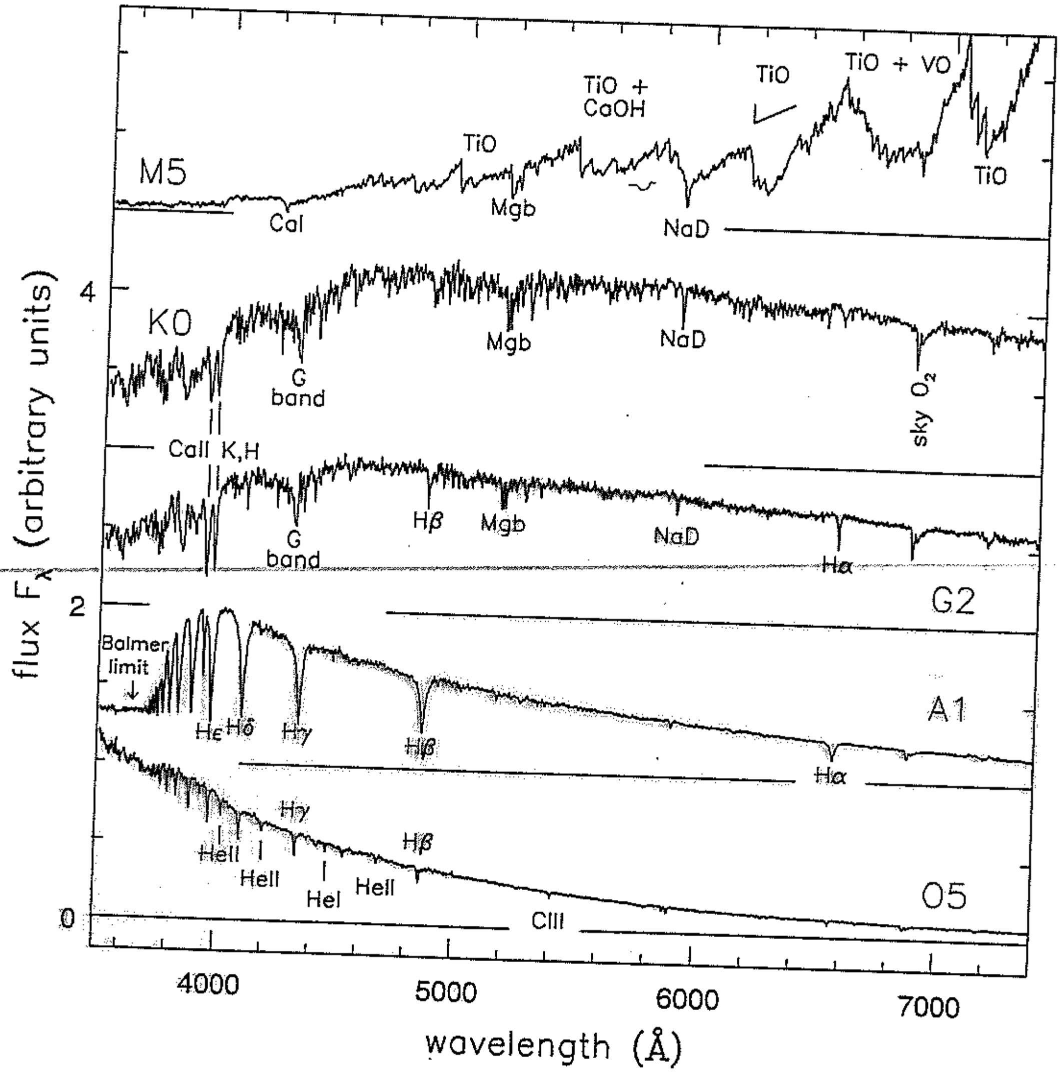


Figure 1.1 Optical spectra of main-sequence stars with roughly the solar chemical composition. From the top in order of increasing surface temperature, the stars have spectral classes M5, K0, G2, A1, and O5 – G. Jacoby *et al.*, spectral library.

The temperatures of O stars exceed 30 000 K. Figure 1.1 shows that the strongest lines are those of HeII (once-ionized helium) and CIII (twice-ionized carbon); the Balmer lines of hydrogen are relatively weak because hydrogen is almost totally ionized. The spectra of B stars, which are cooler, have stronger hydrogen lines, together with lines of neutral helium, HeI. The A stars, with temperatures below 11 000 K, are cool enough that the hydrogen in their atmospheres is largely neutral; they have the strongest Balmer lines, and lines of singly ionized metals such as calcium. Note that the flux decreases sharply at wavelengths less than 3800 Å; this is called the *Balmer jump*. A similar *Paschen jump* appears at wavelengths that are $3^2/2^2$ times longer, at around 8550 Å.

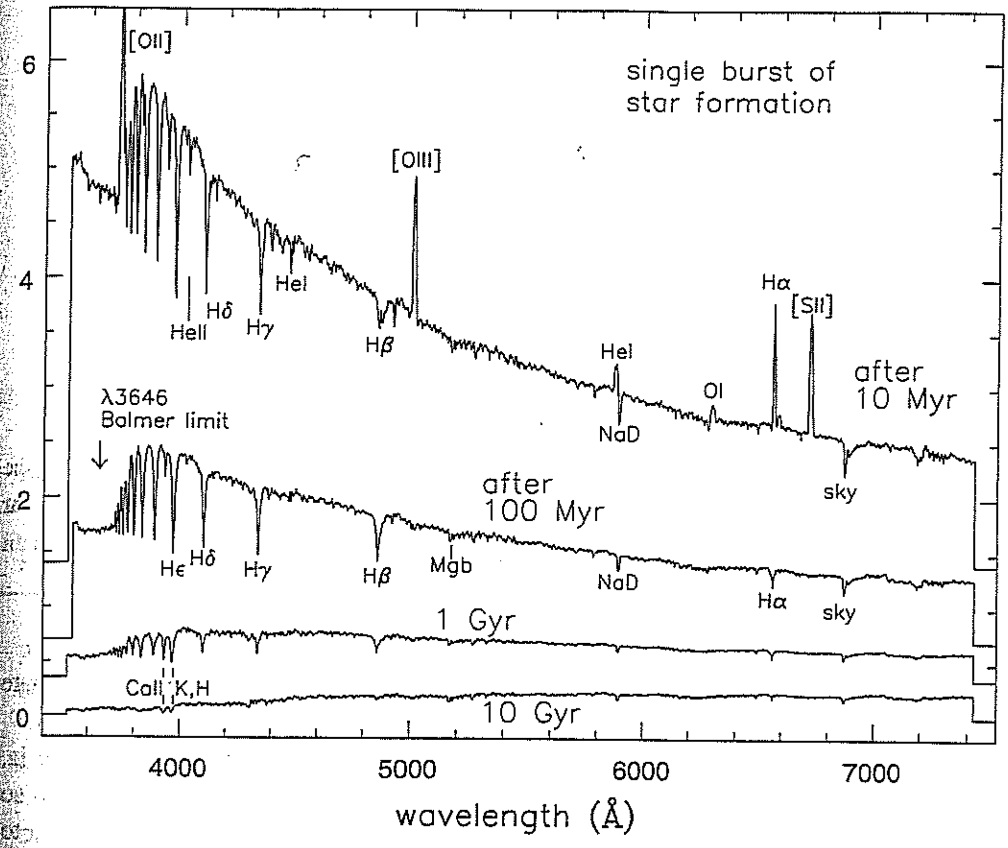


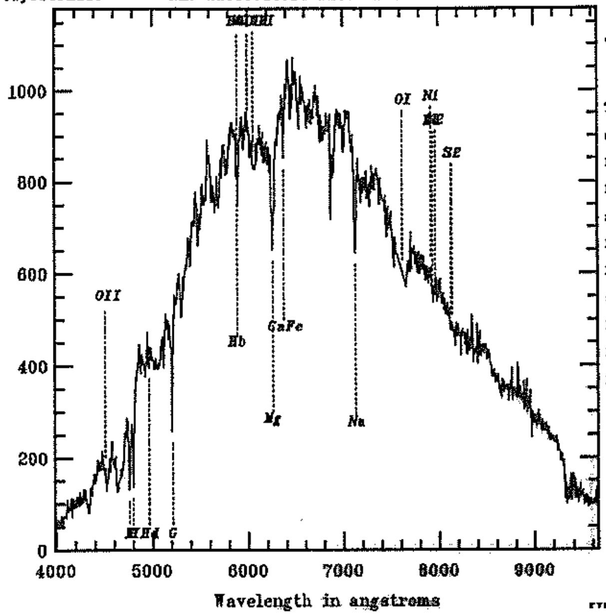
Figure 6.19 Spectra for a 'galaxy' that makes its stars in a 10^8 yr burst, all plotted to the same vertical scale. Emission lines of ionized gas are strong 10 Myr after the burst ends; after 100 Myr, the galaxy has faded and reddened, and deep hydrogen lines of A stars are prominent. Beyond 1 Gyr, the light dims and becomes slightly redder, but changes are much slower – B. Poggianti.

big ellipticals are richer in heavy elements than the midsized ones. The center of a galaxy is also more metal rich than its periphery: Figure 6.20 shows that the magnesium absorption is stronger, the greater the speed required for material to escape from that region of the galaxy. Smaller galaxies may have lost most of their metal-enriched gas, while larger systems were able to trap theirs, incorporating the heavy elements into new stars. Figure 1.5 showed us that metal poor stars of a given mass are bluer, especially while they are burning helium in their cores; so we are not surprised to find that smaller galaxies with lower metal content are bluer.

The most metal-rich parts of galaxies in Figure 6.20 correspond to abundances of 1–2 $Z_\odot$; stars at the center of luminous ellipticals are at least as metal-rich as the Sun. But they do not contain heavy elements in the same proportions as the Sun. Relatively light atoms such as oxygen, sodium, and magnesium are a few times more abundant relative to iron. We saw the same pattern in old metal-poor

File: p.fits JulDate: 2452199.54165 2001-Oct-17 00:00:00.00

Object:A209 RA: 22:57:36.14 DEC: -13:37:38.0 2000.0



Object file BCV: 0.000

VELOCITY = 62852.68 +- 32.79 km/sec _

*Corr vel = 62852.68 +- 29.16 km/sec R= 20.7

Emis vel = INDEF +- INDEF km/sec 0/0 lines

Template	CZ	error	R
m31x_E	62852.875	29.163	20.74
kenn_EL	62678.412	34.695	18.52
kenn_S0	62859.875	32.615	17.81
m31	62856.370	35.752	15.02
kenn_Sb	62854.145	47.133	11.35
kenn_Sa	62806.923	40.645	10.32
star	64089.982	68.464	9.84
kenn_Sc	62752.216	75.235	5.93
kenn_Ir	62644.212	110.463	3.54

No emission lines found?

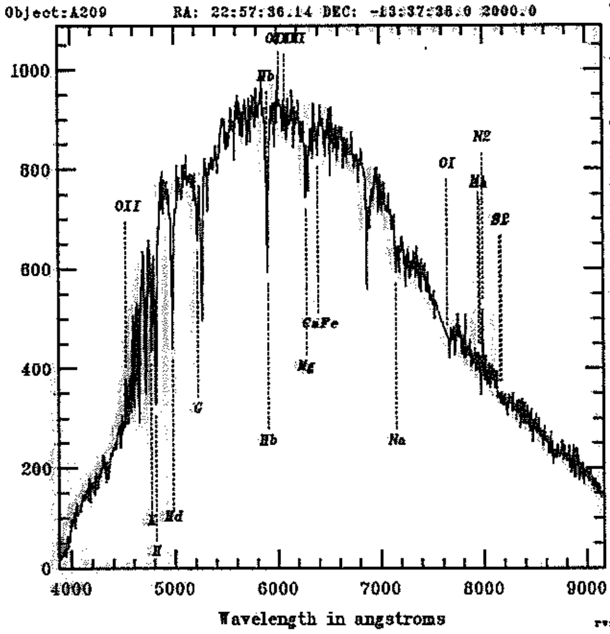
rvsao.xcsao 2.2.4 03-Jun-2002 18:06

cD GALAXY

deep Hδ

File: p.fits JulDate: 2452199.54165 2001-Oct-17 00:00:00.00

Object:A209 RA: 22:57:36.14 DEC: -13:37:38.0 2000.0



Object file BCV: 0.000

VELOCITY = 64178.58 +- 33.23 km/sec _

?Corr vel = 64178.58 +- 29.45 km/sec R= 17.9

Emis vel = INDEF +- INDEF km/sec 0/0 lines

Template	CZ	error	R
kenn_Ir	64178.577	29.450	17.91
kenn_Sc	64214.835	28.620	17.76
kenn_Sb	64421.739	40.374	11.28
kenn_Sa	64393.890	57.052	8.50
kenn_S0	64465.941	58.694	7.38
kenn_EL	64302.048	80.403	6.02
m31x_E	64492.651	88.561	5.29
m31	64351.272	92.847	4.78
star	68457.270	432.061	2.58

No emission lines found?

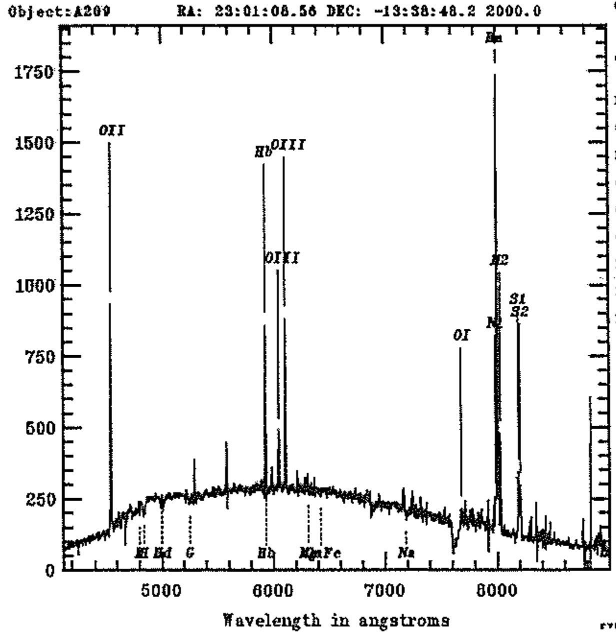
rvsao.xcsao 2.2.4 03-Jun-2002 18:06

E+A GALAXY

POST-STARBUST GALAXY ?

File: p.fits JulDate: 2452201.52465 2001-Oct-19 00:00:00.00

Object:A209 RA: 23:01:08.56 DEC: -13:38:48.2 2000.0



Object BCV: 0.000

VELOCITY = 65618.65 +- 19.46 km/sec _

*Emis vel = 65618.95 +- 12.71 km/sec 10/10 l

Line	Rest	Obs.	CZ	error
OII	3727.38	4548.57	65638.10	12.35
Hb	4861.33	5926.41	65620.30	12.62
OIII	4958.91	6044.71	65642.14	38.47
OIII	5006.84	6102.90	65632.06	9.84
OI	6300.23	7678.93	65604.62	15.97
N1	6548.06	7981.04	65628.54	382.1
Ha	6562.82	7999.15	65612.35	8.84
N2	6583.57	8024.53	65618.26	22.24
S1	6716.44	8186.29	65607.71	12.18
S2	6730.81	8204.05	65618.77	16.11

rvsao.emsao 2.2.4 03-Jun-2002 18:10

EMISSION LINE GALAXY

... STARBUST ?

they have angular
urrounded by a low
does indeed appear to
peculiar morphological
re remarkably similar to
eatures are very weak, if
ker relative to the broad
spectrum, constructed by
in Fig. 2.2.

l galaxies, although some
o types of radio galaxies
activity; broad-line radio
re the radio-loud analogs
, they have a number of
of basic phenomenology,
ant difference is that they

ear emission-line region
scopically, they resemble
., [O I] λ6300 and [N II]
n, and might be present
Filippenko, and Sargent
nel of Fig. 2.1.
ften used to distinguish
he criterion that the flux
wever, because this flux
NER, Seyfert-galaxy, and
m one other on the basis
n, Phillips, and Terlevich
ficially similar emission-
nguished by considering
ns of various lines are a
herefore can be used to
ionizing spectra. Figure
erlevich) diagram which

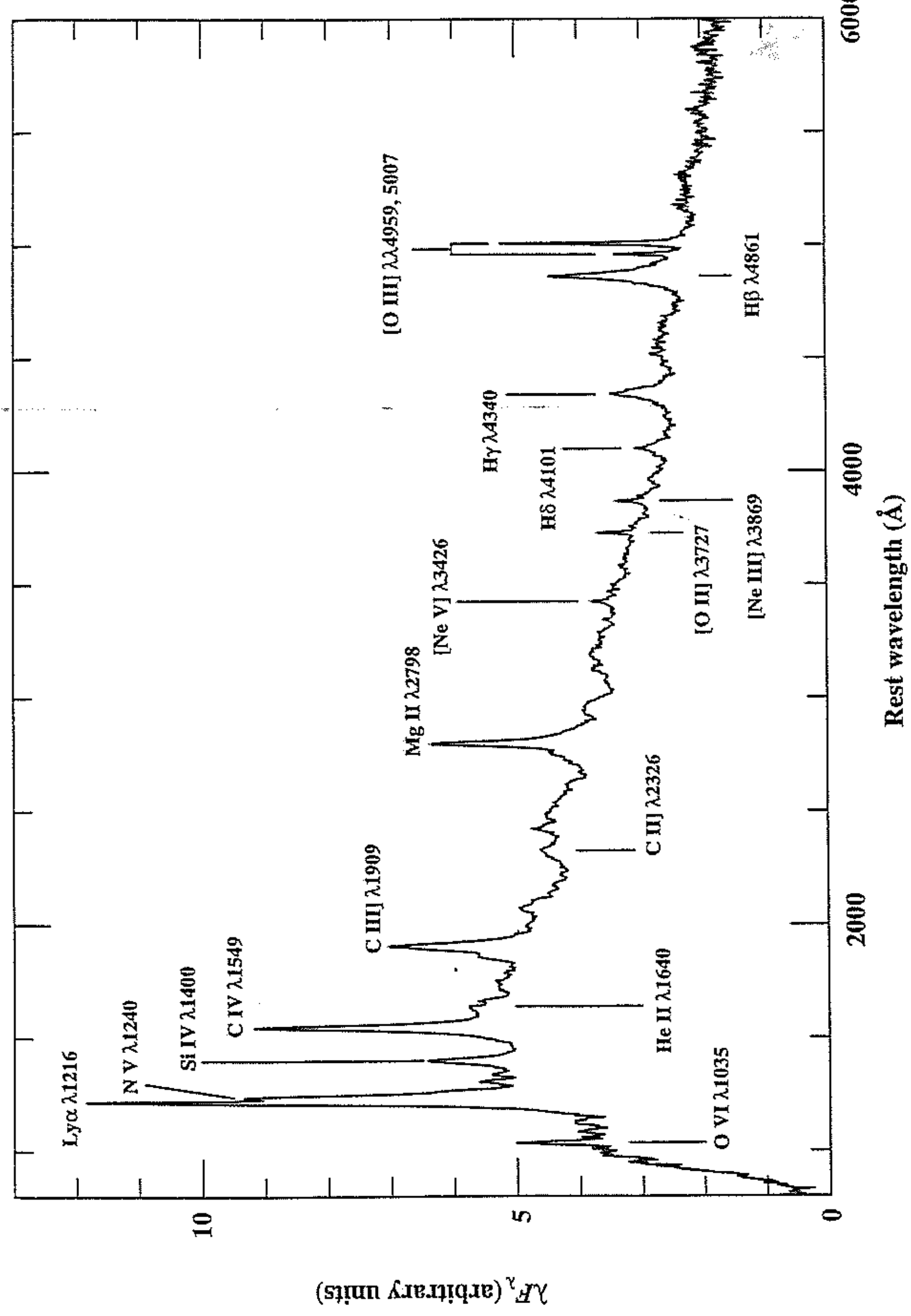
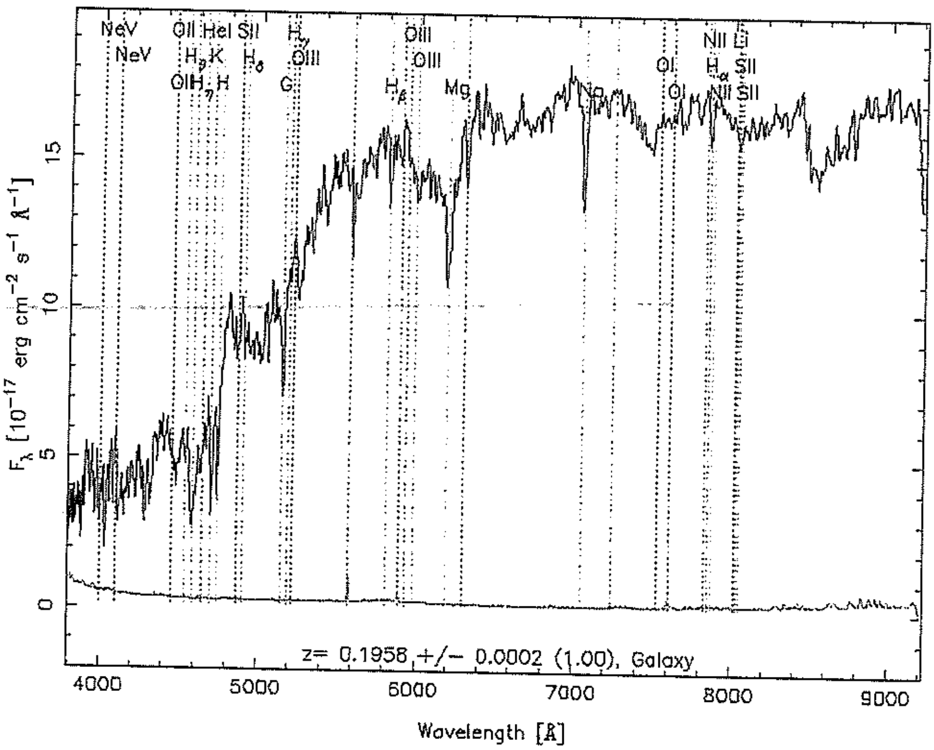


Fig. 2.2. A mean QSO spectrum formed by averaging spectra of over 700 QSOs from the Large Bright Quasar Survey (Francis *et al.* 1991). Prominent emission lines are indicated. Data courtesy of P.J. Francis and C.B. Foltz.

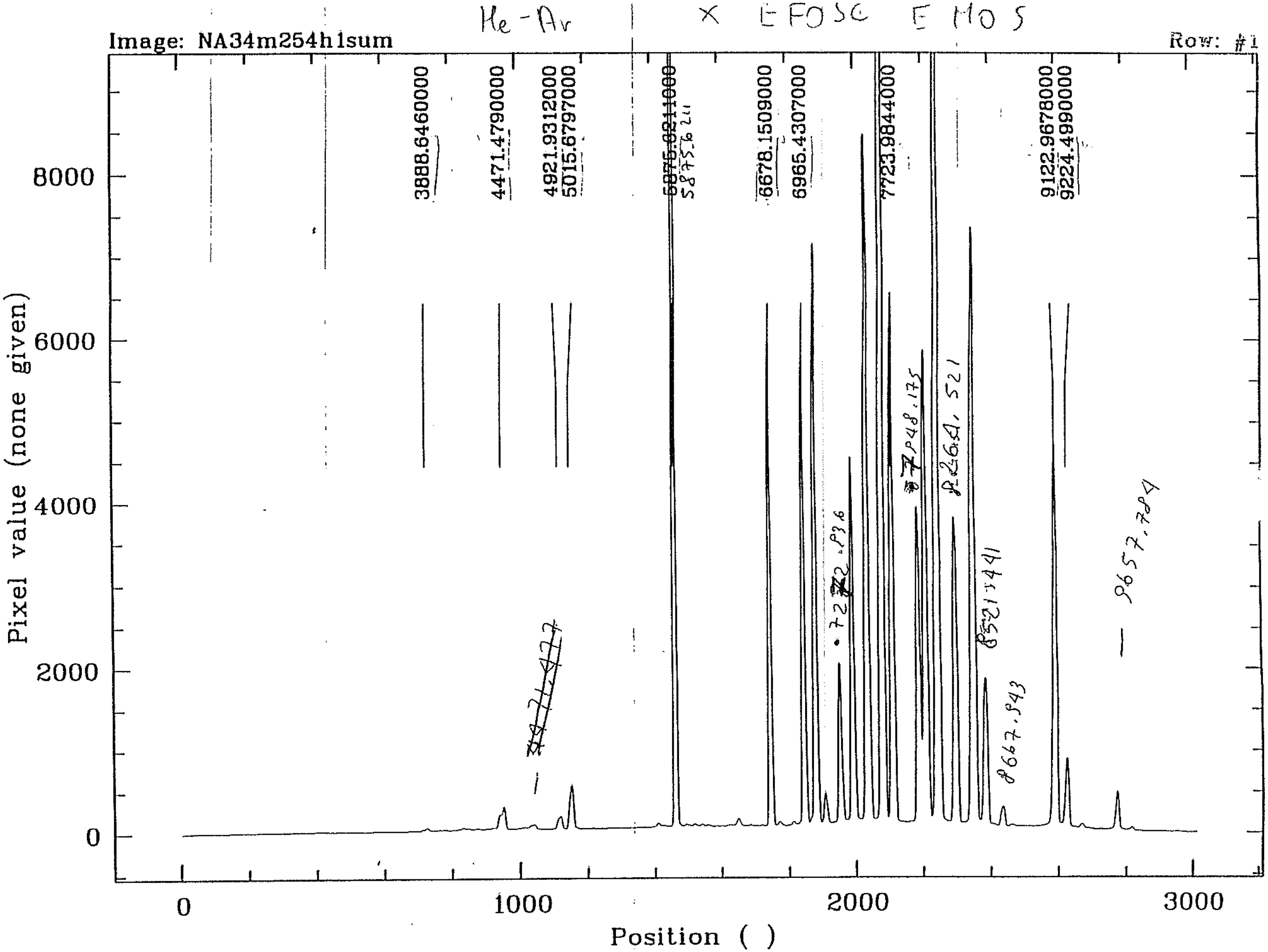
A1240 radio
KO = 460
accept

SDSS Plate 1365, MJD 53062, Rerun 26, Fiber 106



See the CAS Explorer page for more information on this object

File type	Directory	File name
The extracted, calibrated spectrum for this fiber, with 1d parameters	1d_26/1365/1d	spSpec-53062-1365-106.fit
Plot of the extracted, calibrated spectrum for this fiber, in gif image	1d_26/1365/gif	spPlot-53062-1365-106.gif
Plot of the extracted, calibrated spectrum for this fiber, in gzipped postscript	1d_26/1365/gif	spPlot-53062-1365-106.ps.gz
Atlas image of this object	ss_26/1365/spAtlas	spAtlas-1365-53062-106.fit
List of objects in the plate with imaging parameters	ss_26/1365	spObj-1365-53062-26.fit
Log file from the 1d data reduction	ss_26/1365	spDiag1d-53062-1365.par
The extracted, calibrated spectra for a plate	2d_26/1365	spPlate-1365-53062.fits
best fit spectroscopic classifications and redshifts	2d_26/1365	spZbest-1365-53062.fits
line fits for the spectra	2d_26/1365	spZline-1365-53062.fits
all fit spectroscopic classifications and redshifts	2d_26/1365	spZall-1365-53062.fits
Gzipped, tarred collection of spPlate and spSpec files for the plate	ss_tar_26	1365.tar.gz
A tar file with the output of the SEGUE Stellar Parameter Pipeline	sspp_26	1365-53062.tgz


He-Ar
X EFOSC EMOS
Image: NA34m254h1sum
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5015.6797000
5875.6211000
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6965.4307000
7723.9844000
9122.9678000
9224.4990000
7272.936
7948.175
8264.521
8521.441
8667.943
9657.784
Pixel value (none given)
Position ( )
0
1000
2000
3000
0
2000
4000
6000
8000

File: home$iraf/mos4.10sals.fits HJD: 2451221.49979

Object:EIS_0951-2 RA: 147:53:03.8 DEC: -20:47:07.9 2000.0

1999-Feb-12 00:00:00.00

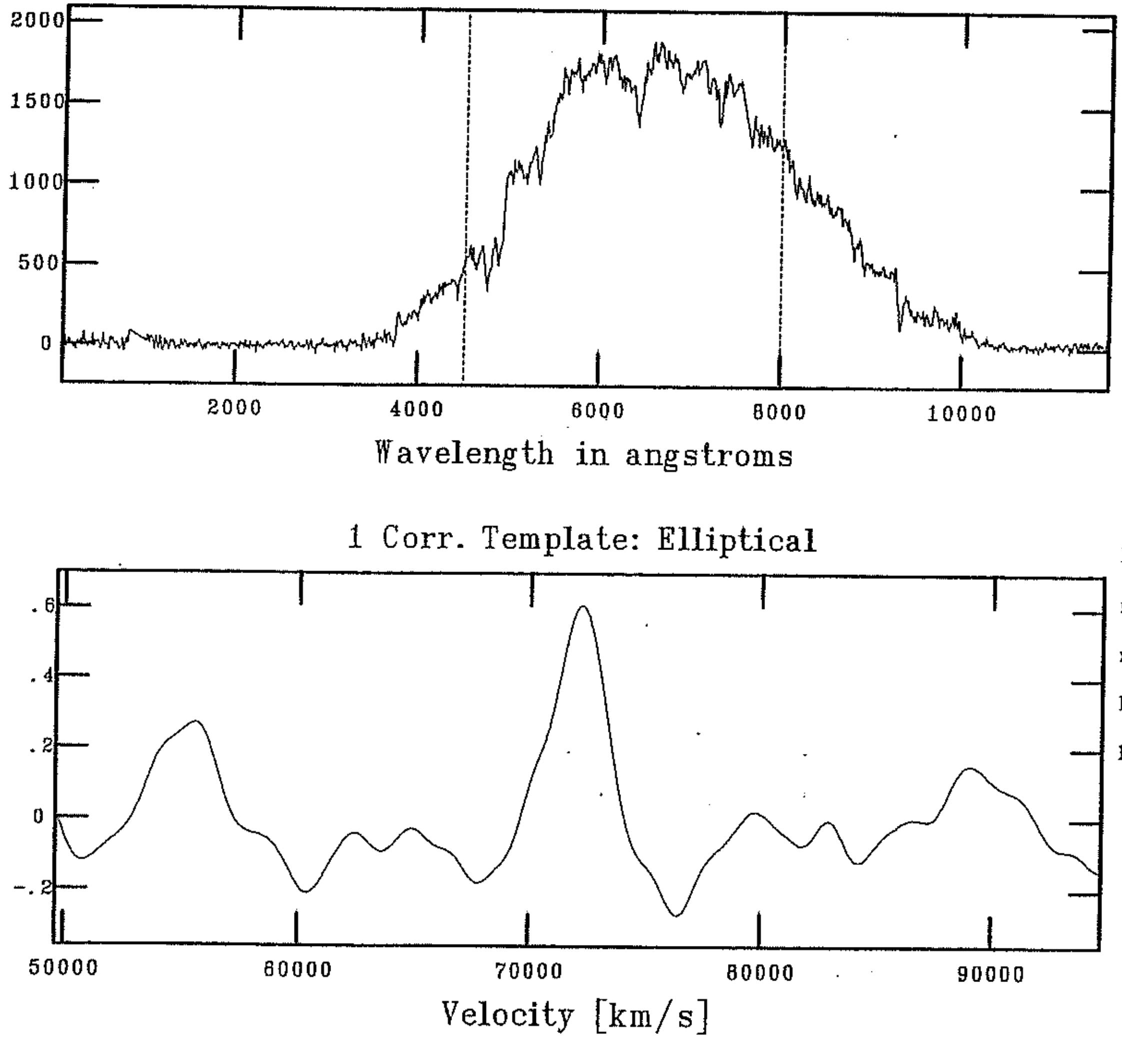
Object BCV: 0.000

lambda: 4519.1 8000.0

nbins: 2048x2 -em

Filter: 10 20 160 280

Frac. endmask: 0.05



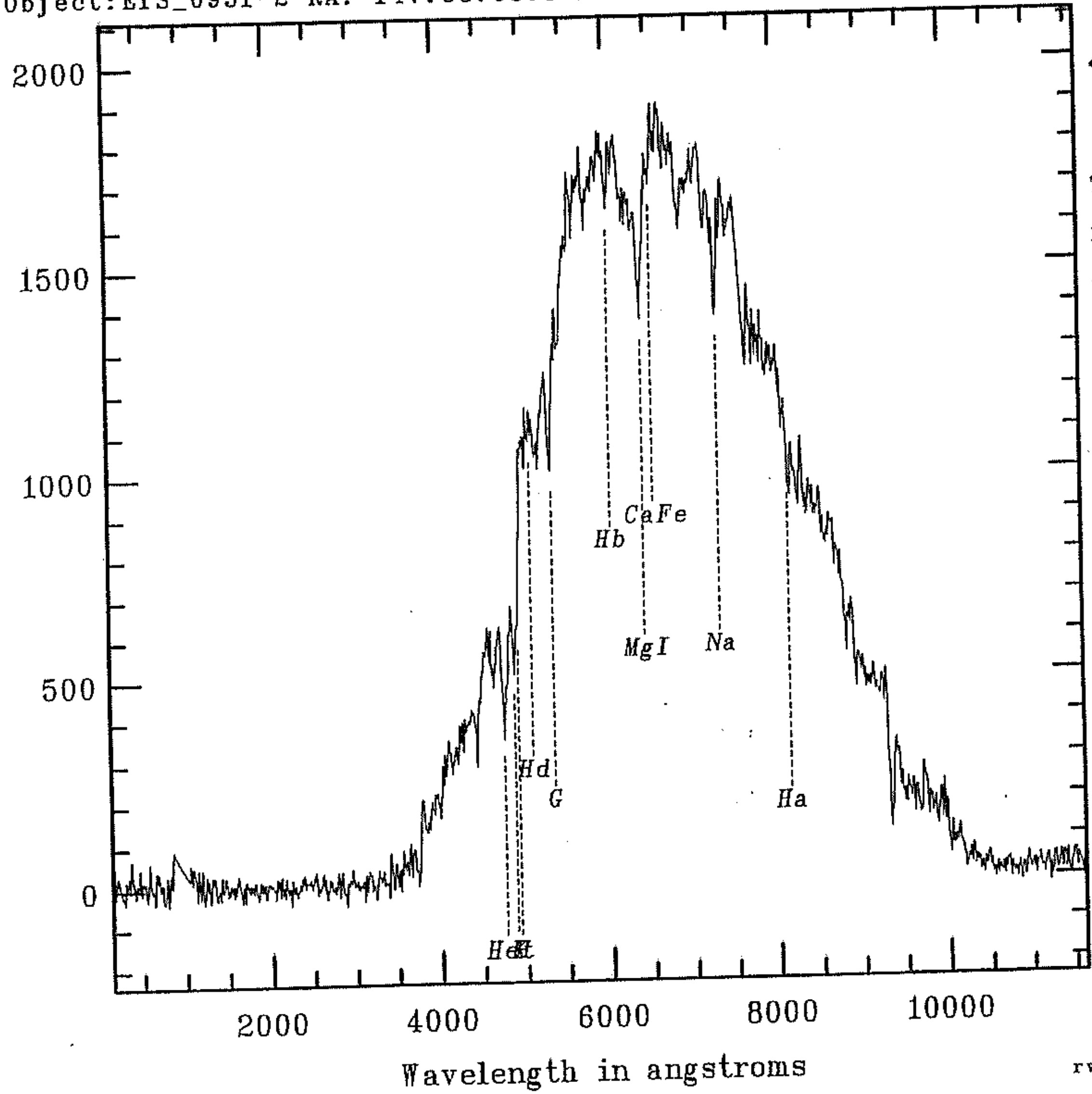
Template	CZ	error	R	
kenn_EL	72202.9	86.066	8.85	-e
walt_s1	72306.3	120.474	8.65	-e
kenn_S0	72277.9	80.919	8.12	-e
walt_s2	72924.5	114.755	7.86	-e
kenn_Sb	72332.6	111.228	6.67	-e-f
kenn_Sa	72339.1	105.253	6.29	-e-f
m31	72481.9	99.463	6.18	-e
m31x_E	72496.7	133.548	4.51	-e
kenn_Sc	72231.7	161.633	3.00	-e-f
kenn_Ir	169524.8	318.444	2.58	-e-f

rvsao.xcsao 2.0b17 31-Mar-1999 10:27

0.50-ht. peak fit, 29 pts.

File: home$iraf/mos4.10sals.fits JulDate: 2451221.50000

Object:EIS_0951-2 RA: 147:53:03.8 DEC: -20:47:07.9 2000.0



1999-Feb-12 00:00:00.00

Object BCV: 0.000

VELOCITY = 72202.95 +- 87.36 km/sec -

*Corr vel = 72202.95 +- 86.07 km/sec R= 8.85

Emis vel = INDEF +- INDEF km/sec 0/0 lines

Template	CZ	error	R
kenn_EL	72202.945	86.066	8.85 -e
walt_s1	72306.276	120.474	8.65 -e
kenn_S0	72277.926	80.919	8.12 -e
walt_s2	72924.450	114.755	7.86 -e
kenn_Sb	72332.556	111.228	6.67 -e -f
kenn_Sa	72339.054	105.253	6.29 -e -f
m31	72461.908	99.463	6.18 -e
m31x_E	72496.739	133.546	4.51 -e
kenn_Sc	72231.741	161.633	3.00 -e -f
kenn_Ir	169524.76	318.444	2.58 -e -f

No emission lines found?

rvsao.xcsao 2.0b17 31-Mar-1999 10:27

sky (~55721)

NOAO/IRAF V2.11.2EXPORT drsguest@suw006 Fri 10:25:43 10-Nov-2000
[skymeanx.fits]: EIS0045-2948a 3300. ap:1 beam:0