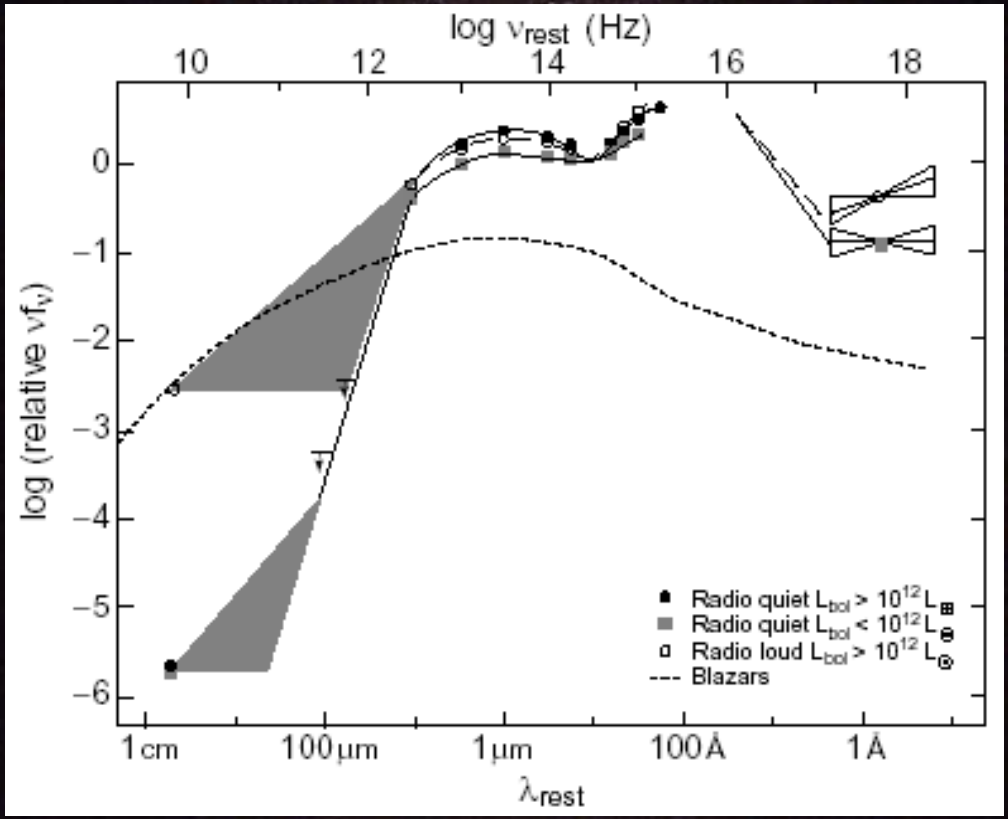
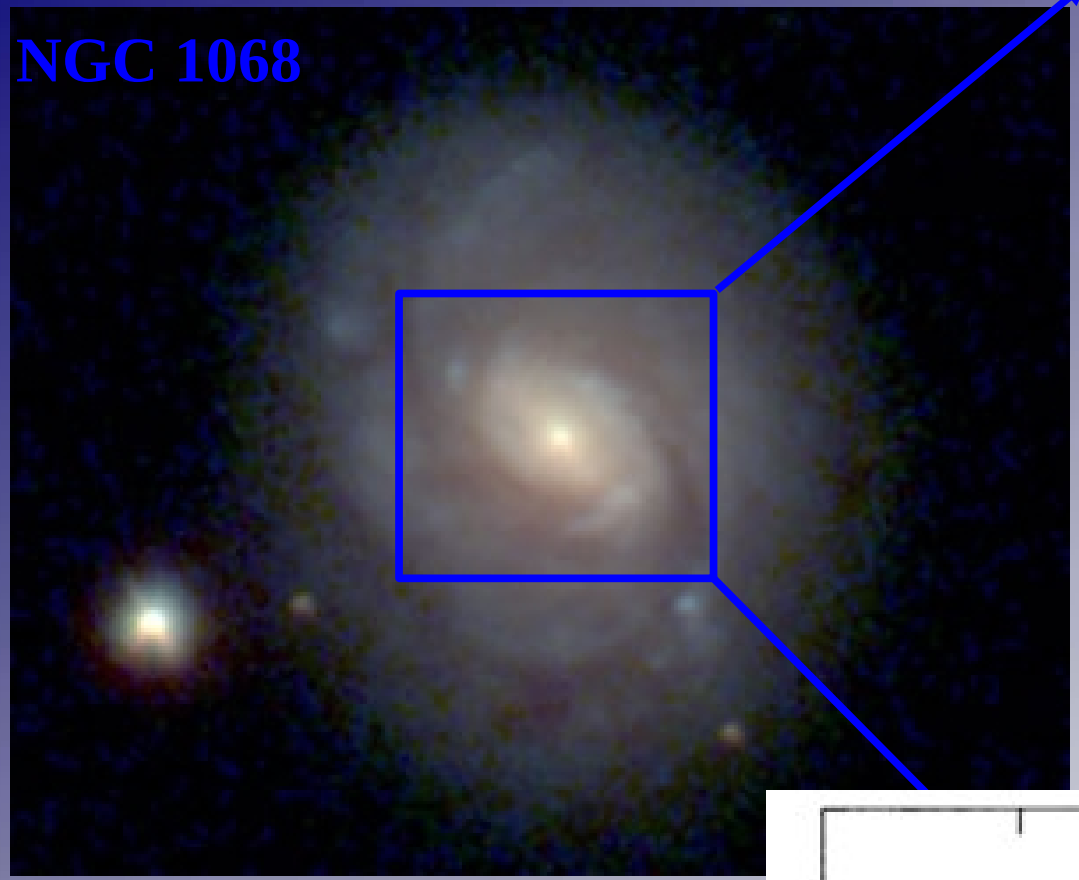
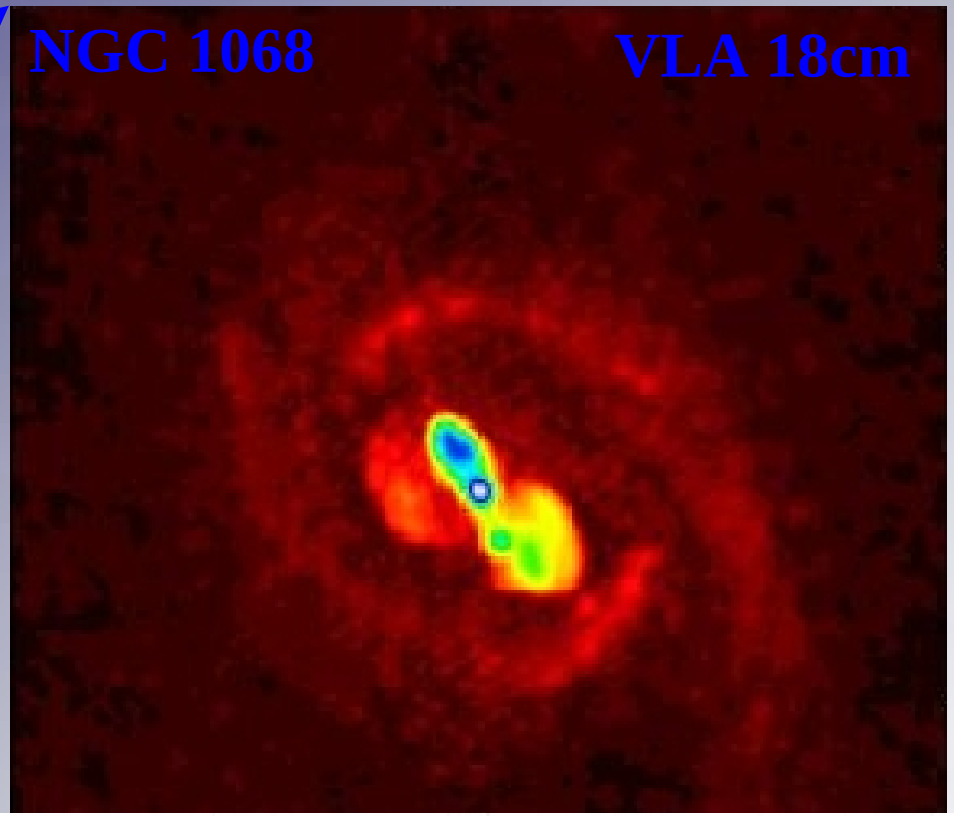
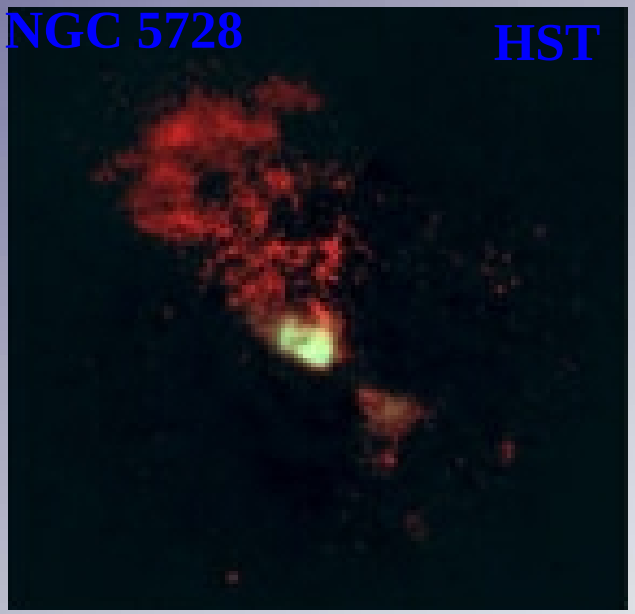
The Outflow from the Nucleus of a Purportedly Obscured Seyfert

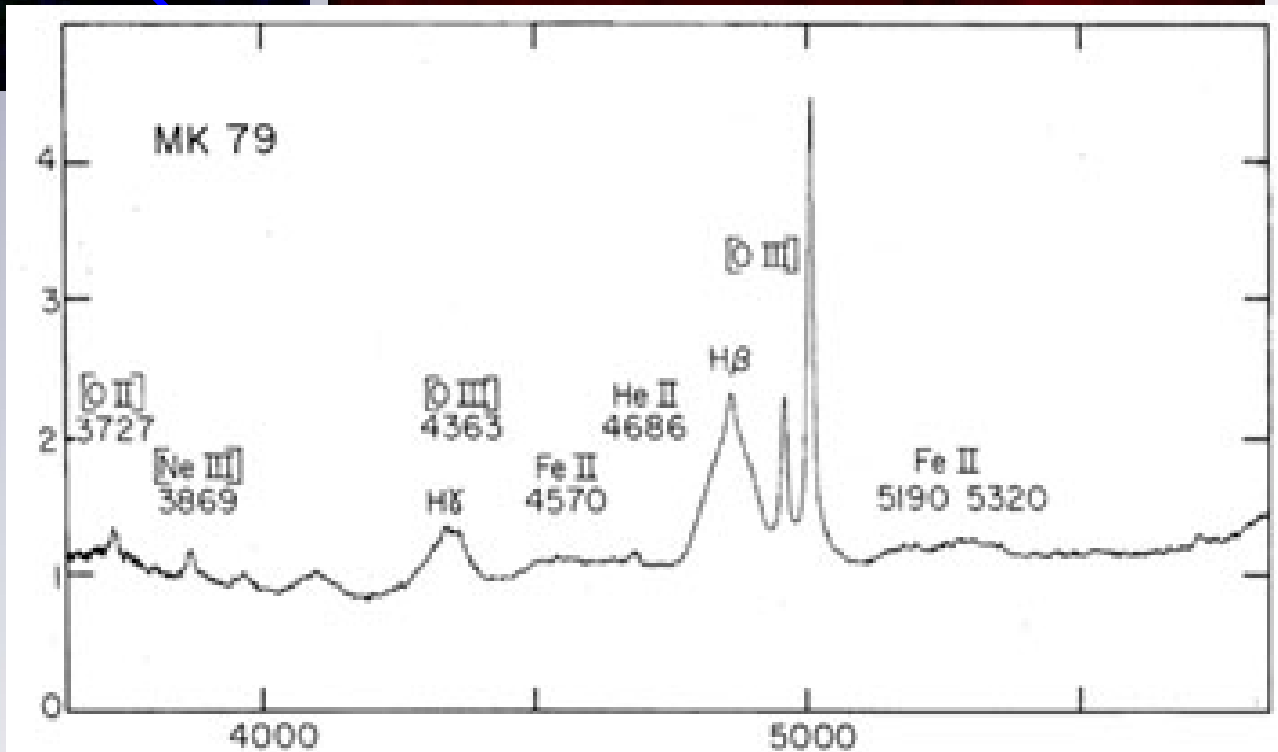


Beckwith etal

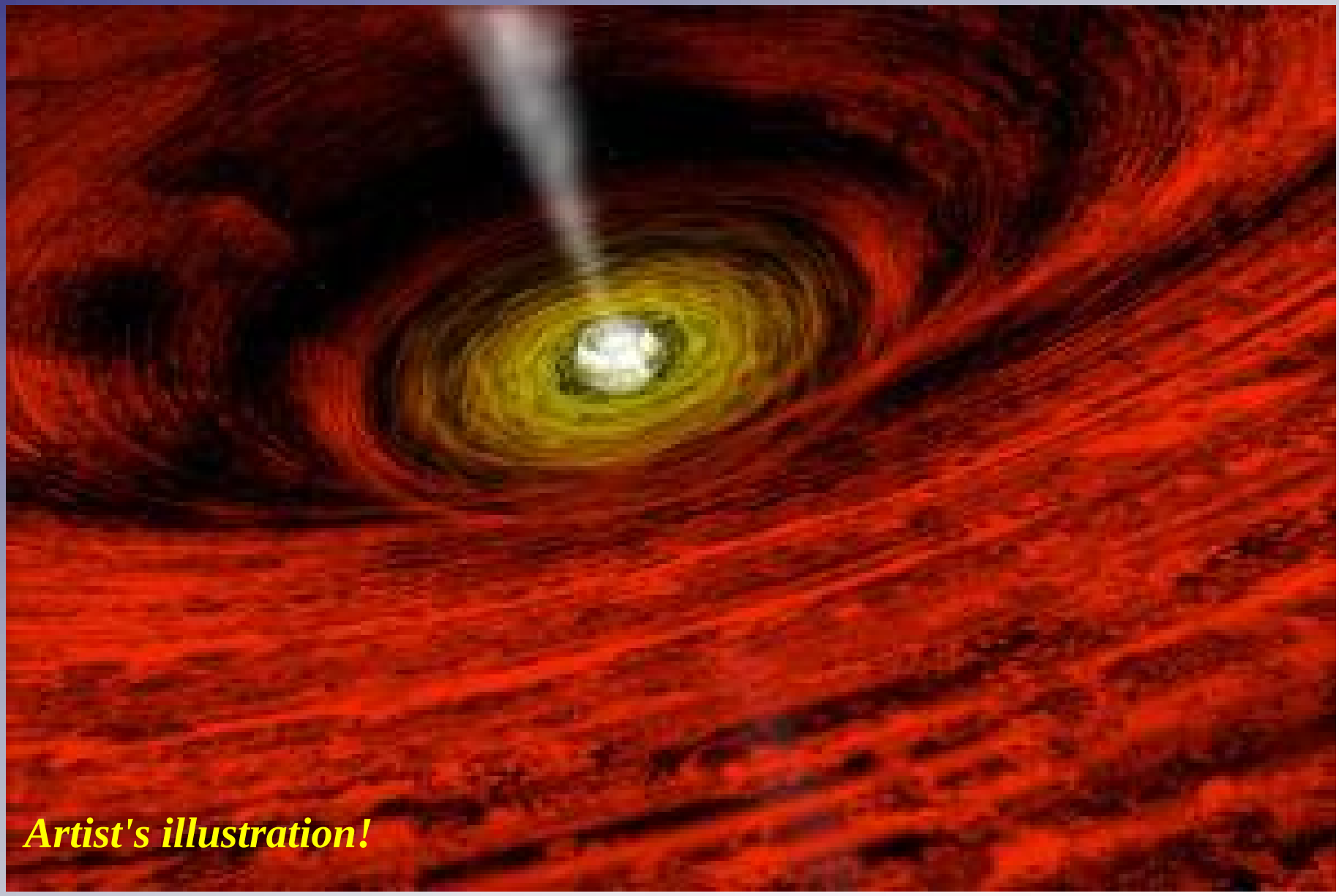

NGC 1068

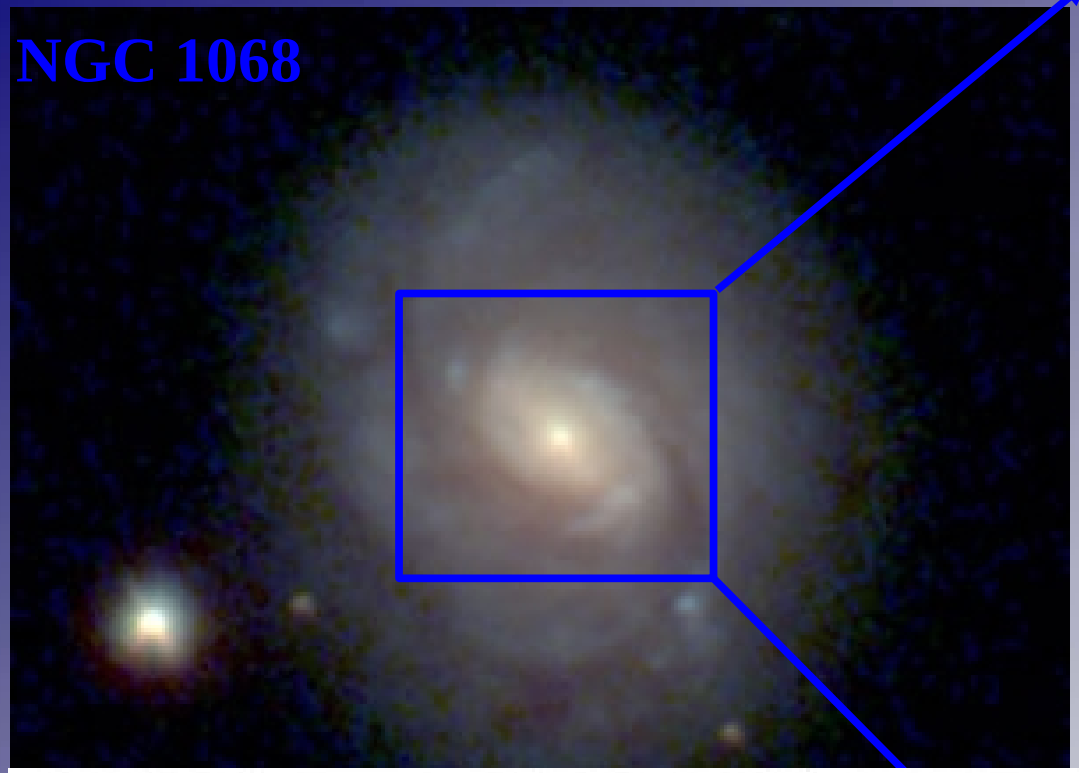

NGC 1068
VLA 18cm

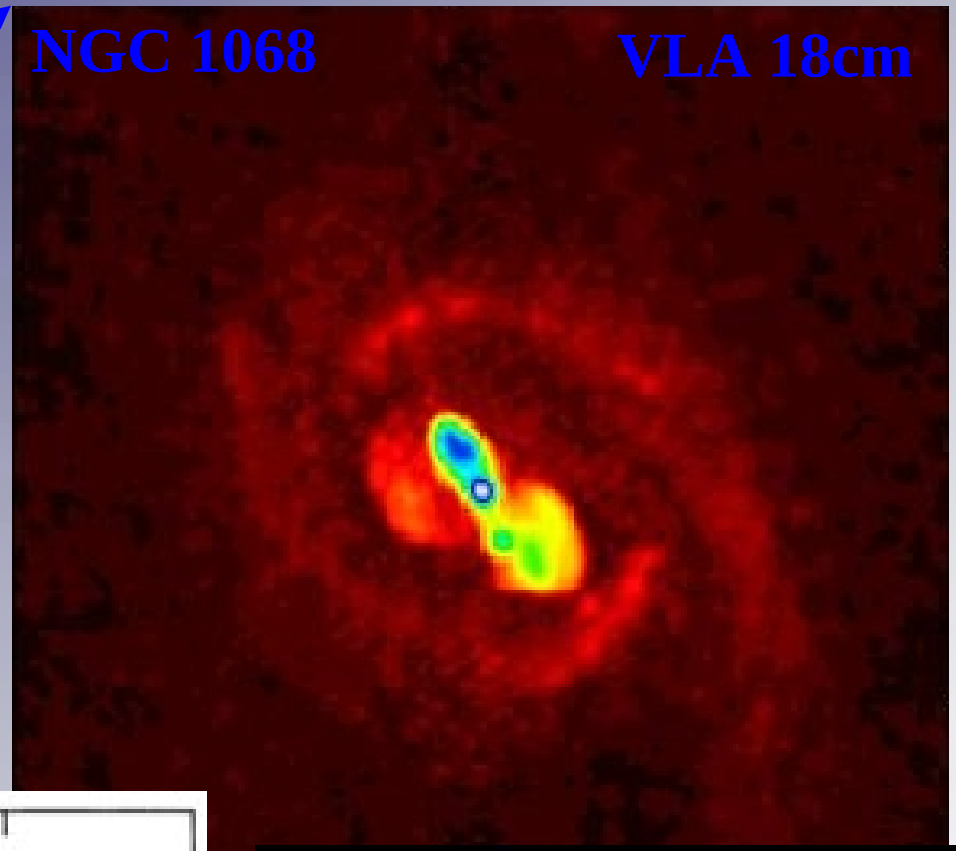

NGC 5728
HST

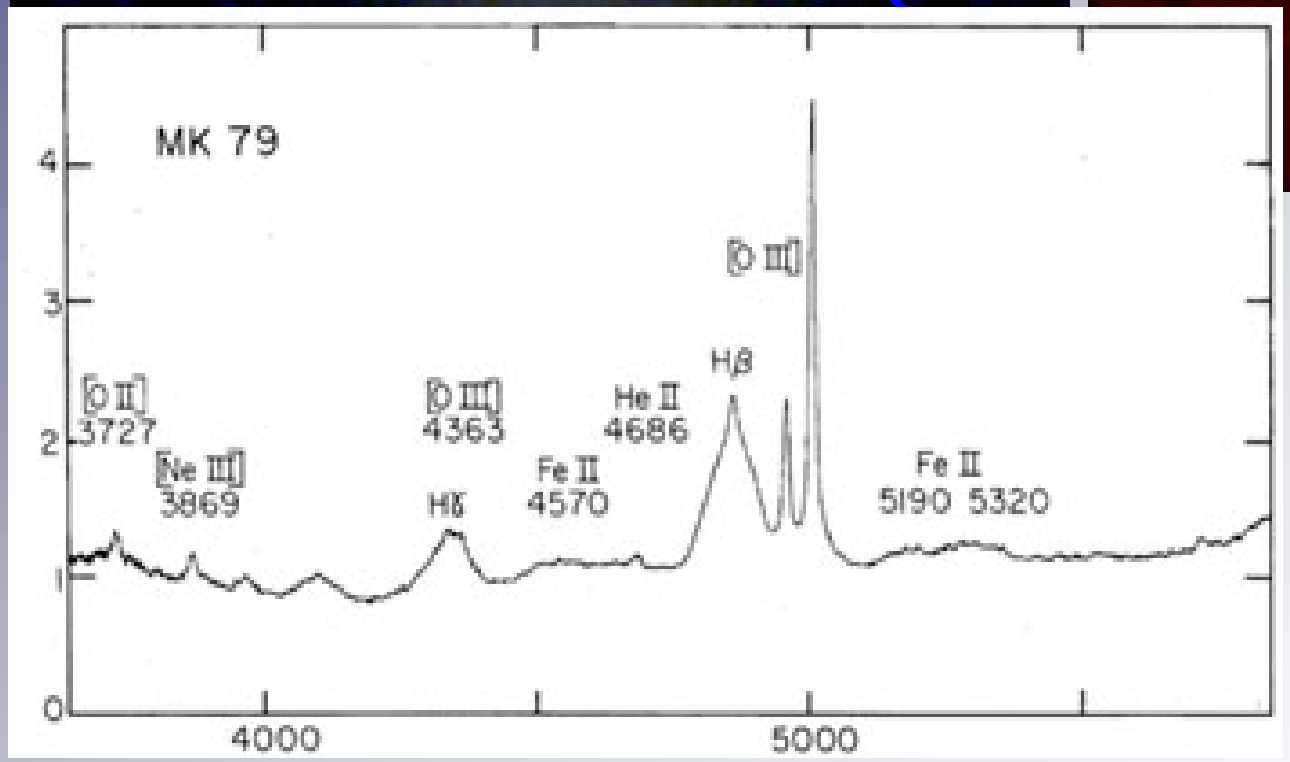

MK 79
[O II]
3727
[Ne III]
3869
Hδ
[O III]
4363
Fe II
4570
He II
4686
Hβ
[O III]
Fe II
5190 5320
0
1
2
3
4
4000
5000

Active Galaxies: the accreting phase of a supermassive blackhole

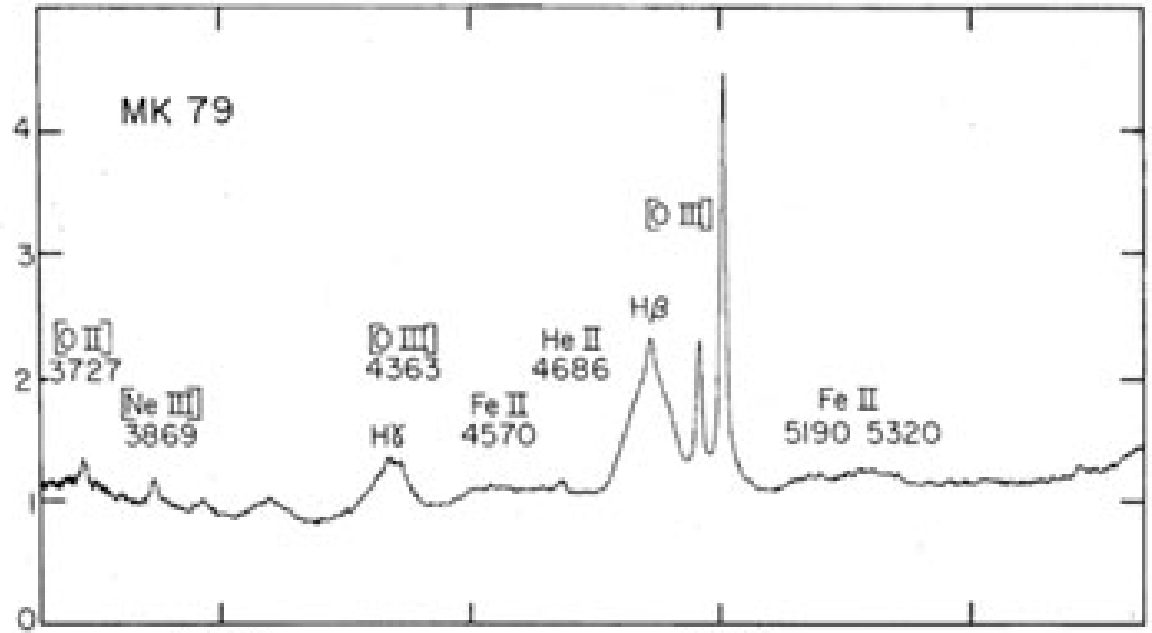


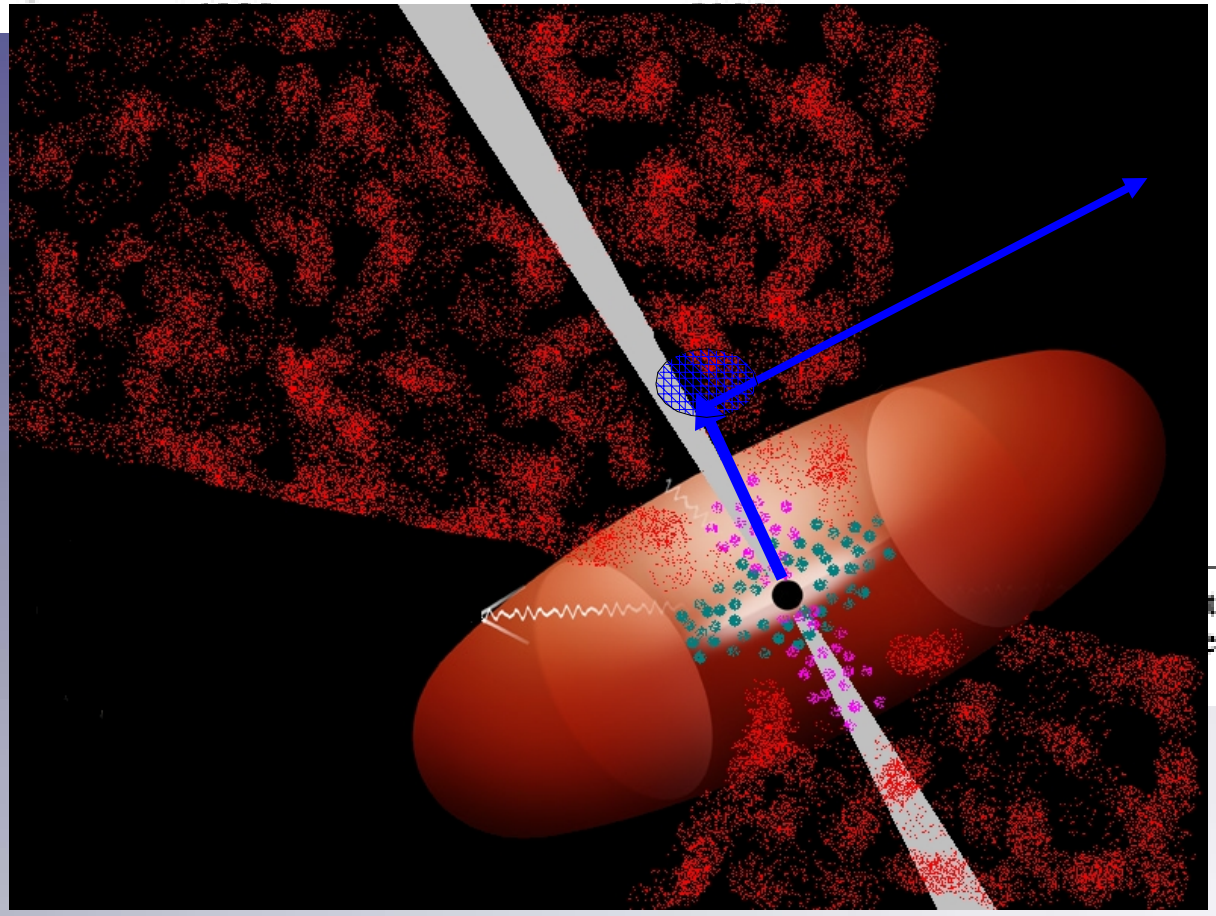

NGC 1068

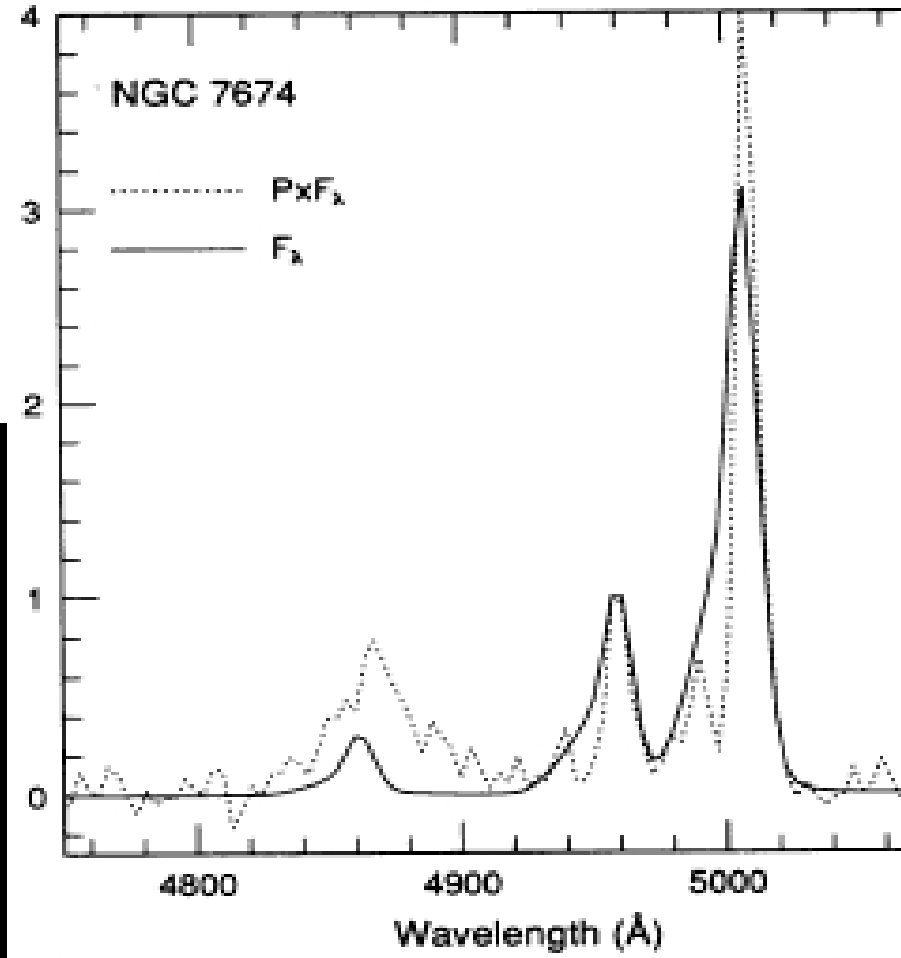

NGC 1068
VLA 18cm


MK 79
[O II]
3727
[Ne III]
3869
[O III]
4363
Hγ
Fe II
4570
He II
4686
Hβ
[O III]
Fe II
5190 5320
0
1
2
3
4
4000
5000


NGC1068
Chandra





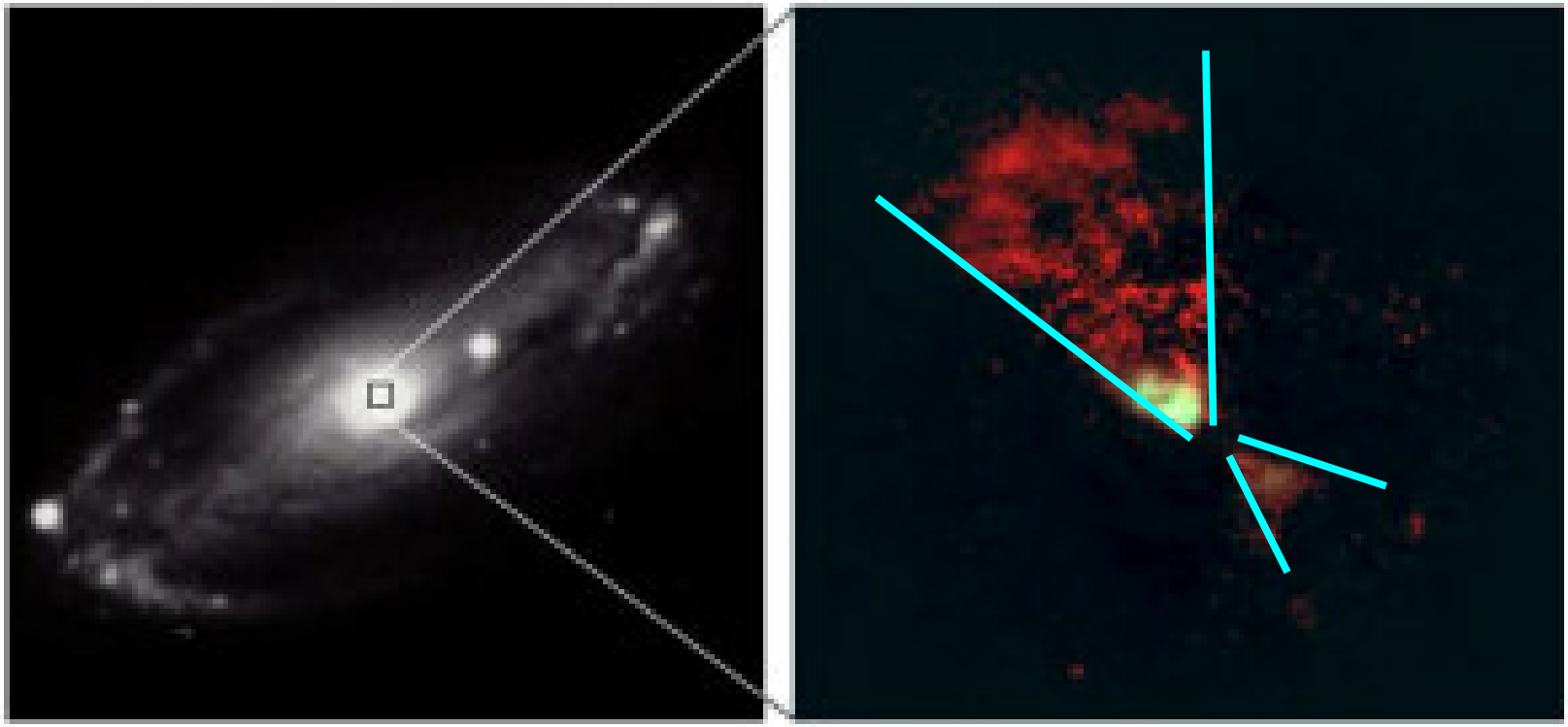


—Profiles of the [O III] lines in F_λ and $P \times F_\lambda$, norm
ty of [O III] λ4959. Note that in $P \times F_\lambda$, the lines are n
etric.

NGC 5728

Hubble Space Telescope

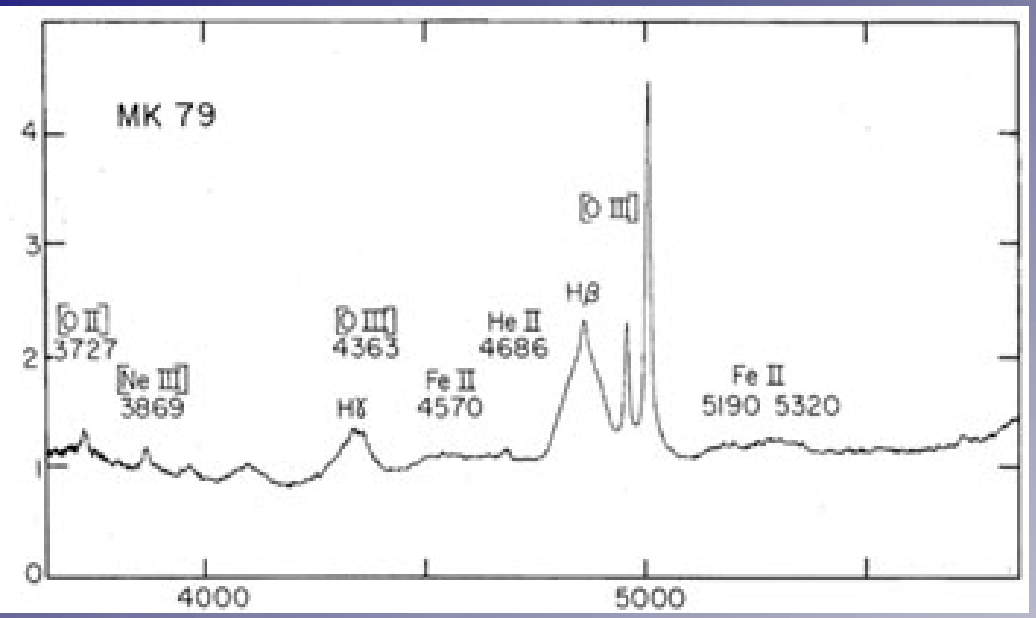
Wide Field / Planetary Camera



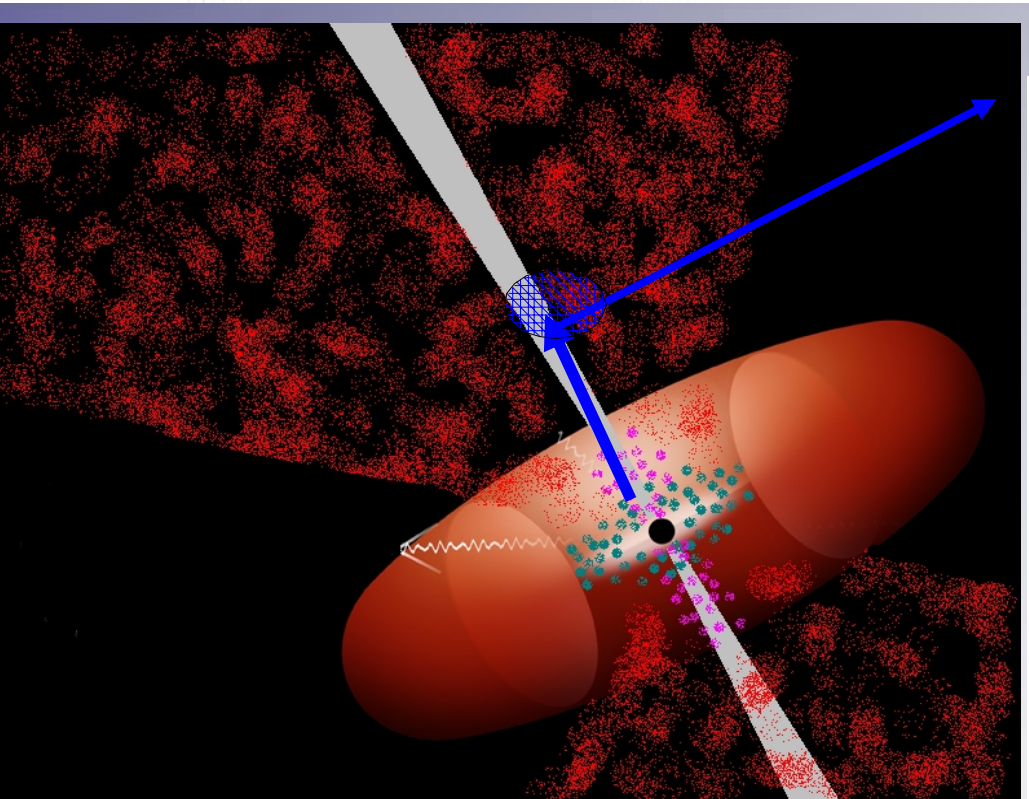
Ground View

HST View

Outflows are important:



- *Energetics*
- *Metallicity*
- *Star formation*
- *Dust*



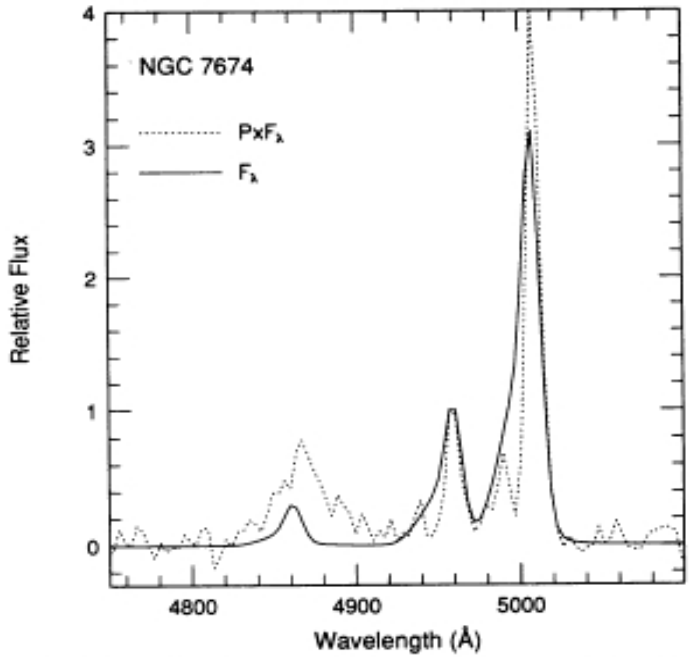
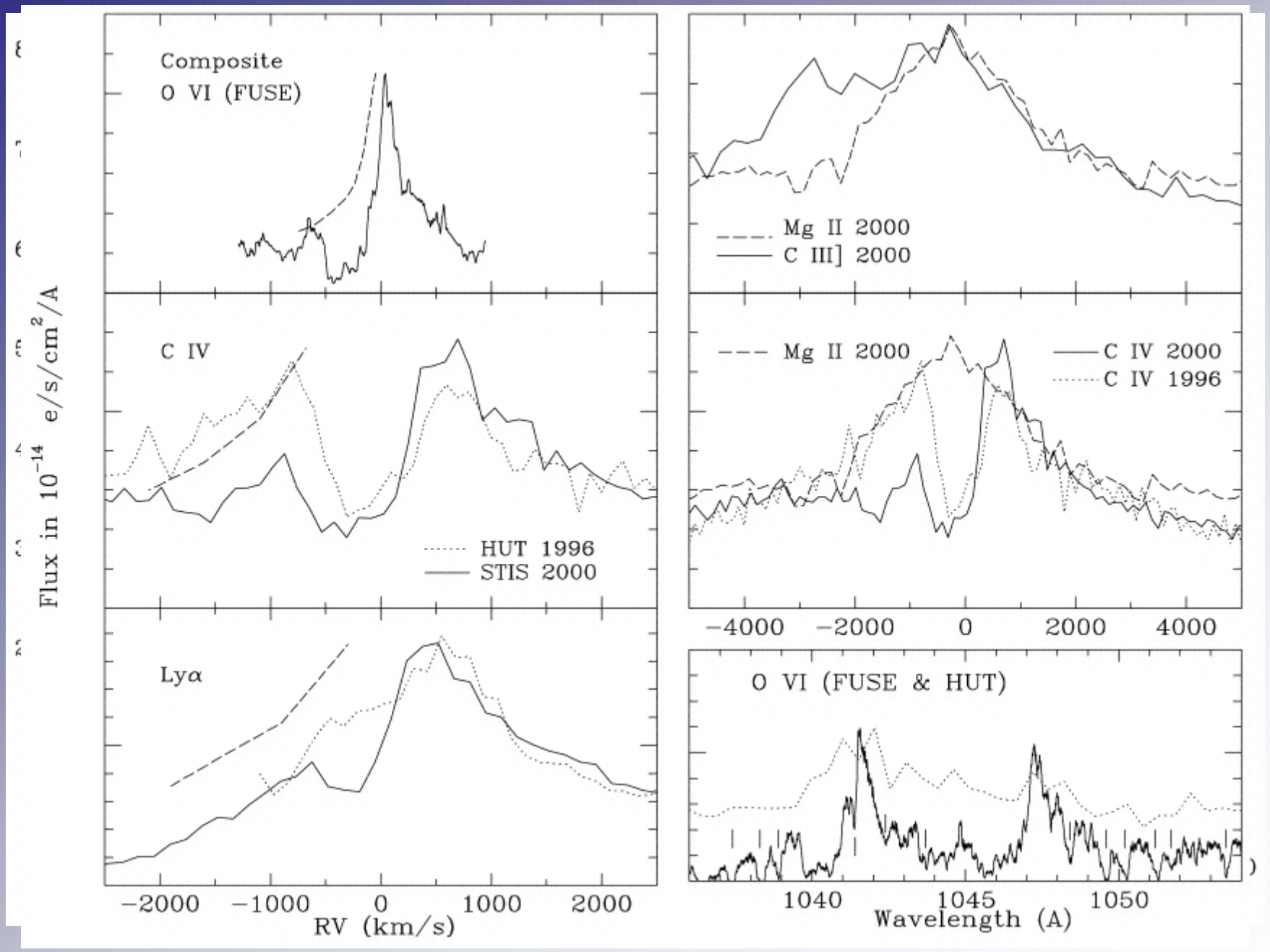
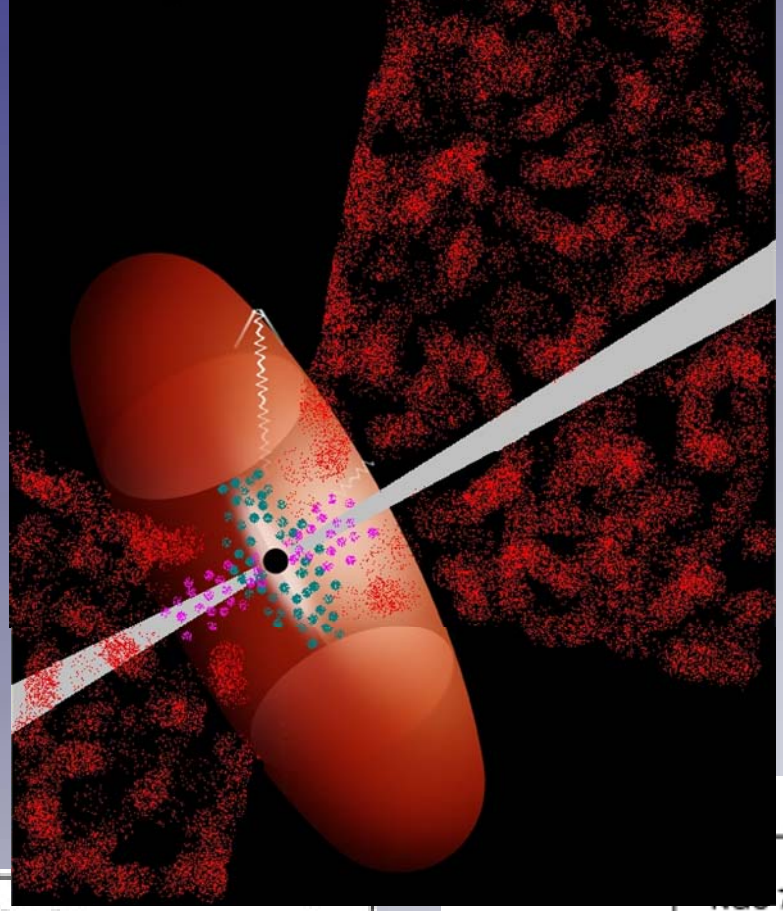
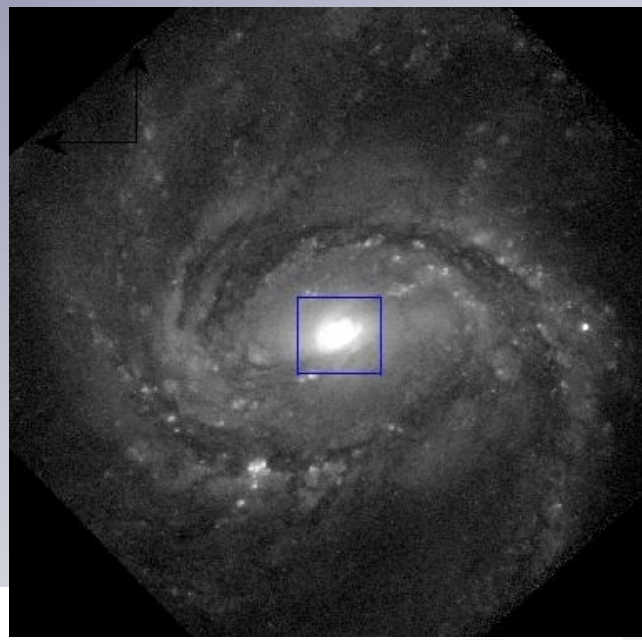


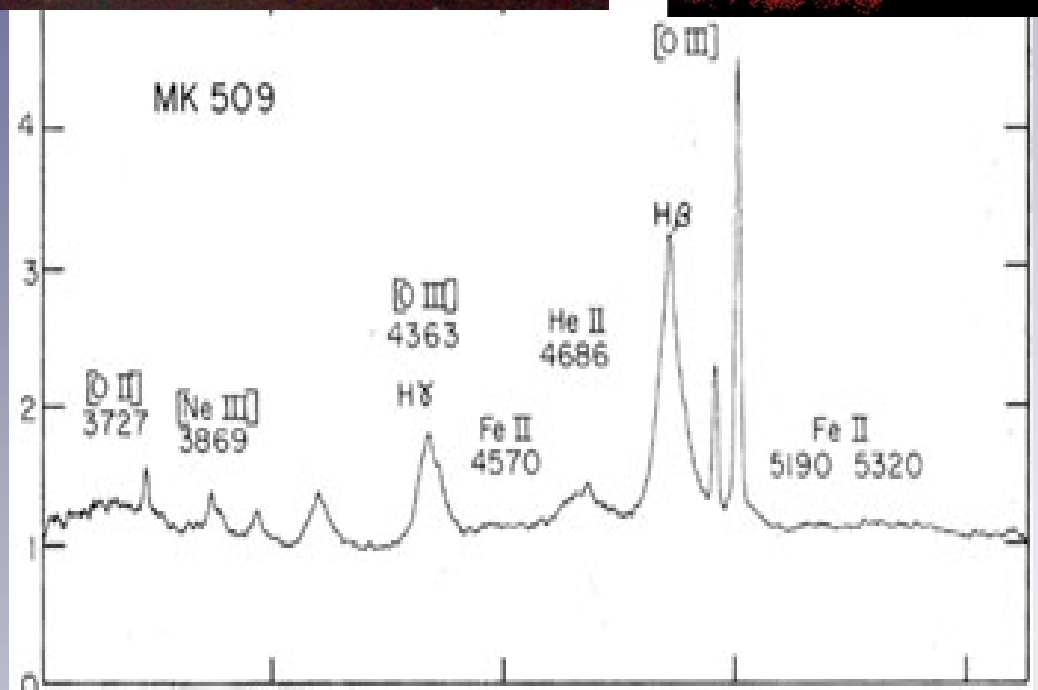
FIG. 13.—Profiles of the [O III] lines in F_λ and $P \times F_\lambda$, normalized at the

Hutchings et al 2001








MK 509
[O III]
Hβ
[O III]
4363
He II
4686
Hγ
[O II]
3727
[Ne III]
3869
Fe II
4570
Fe II
5190 5320
4
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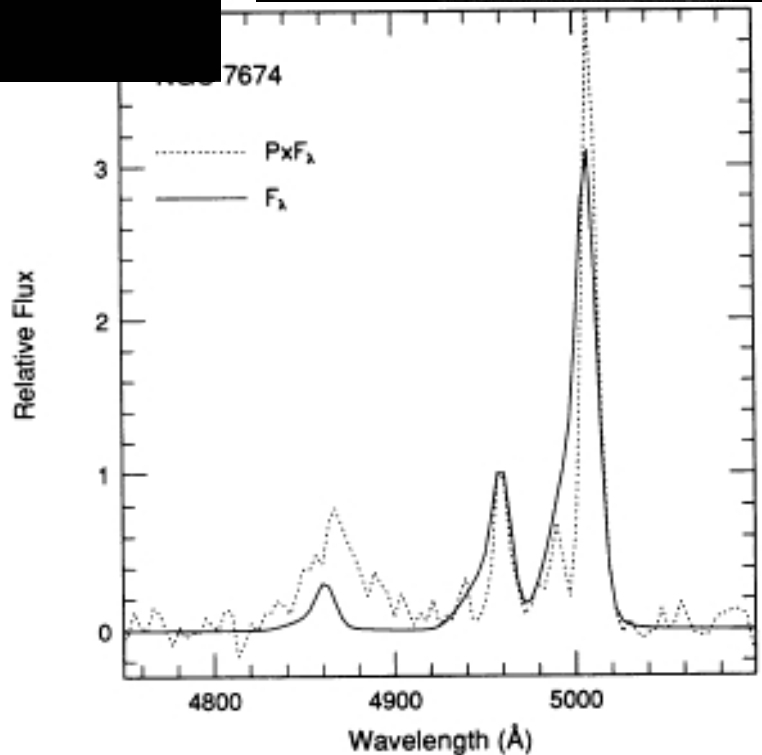
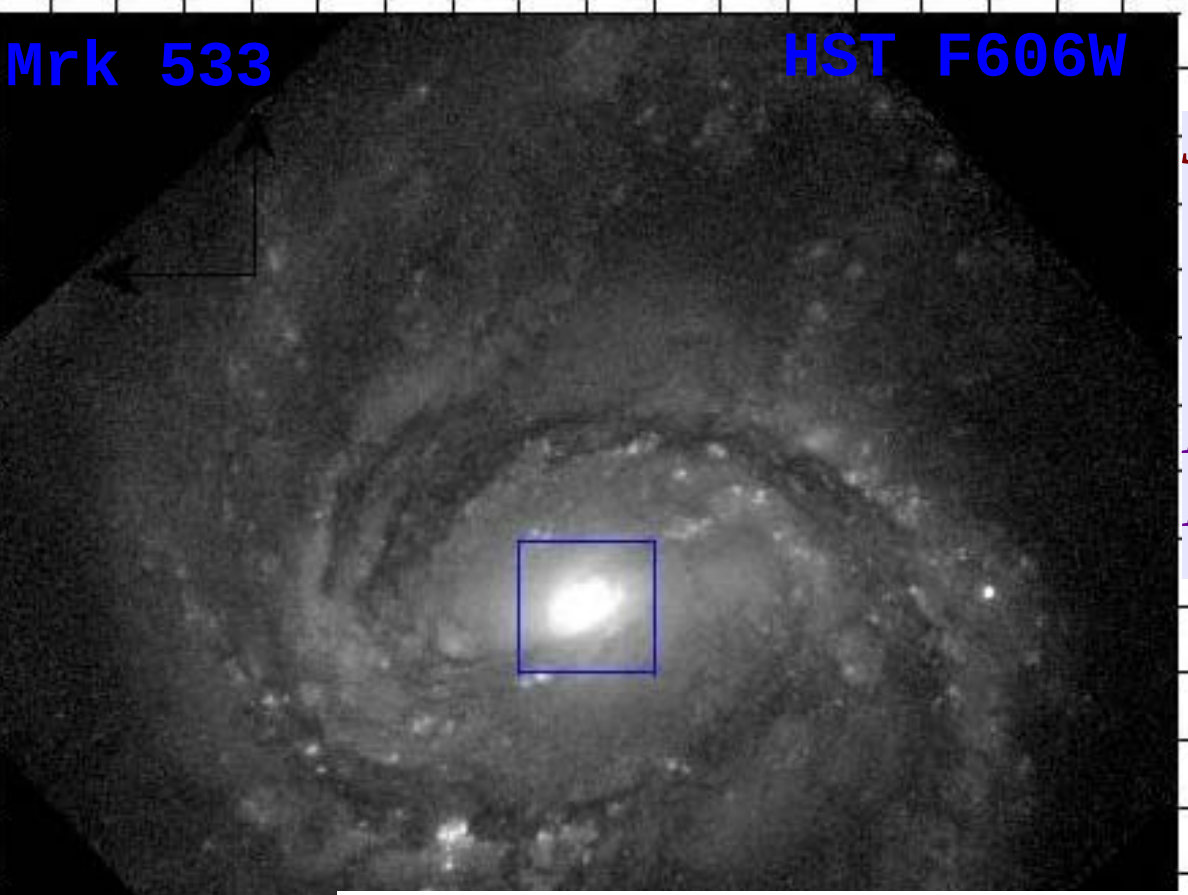
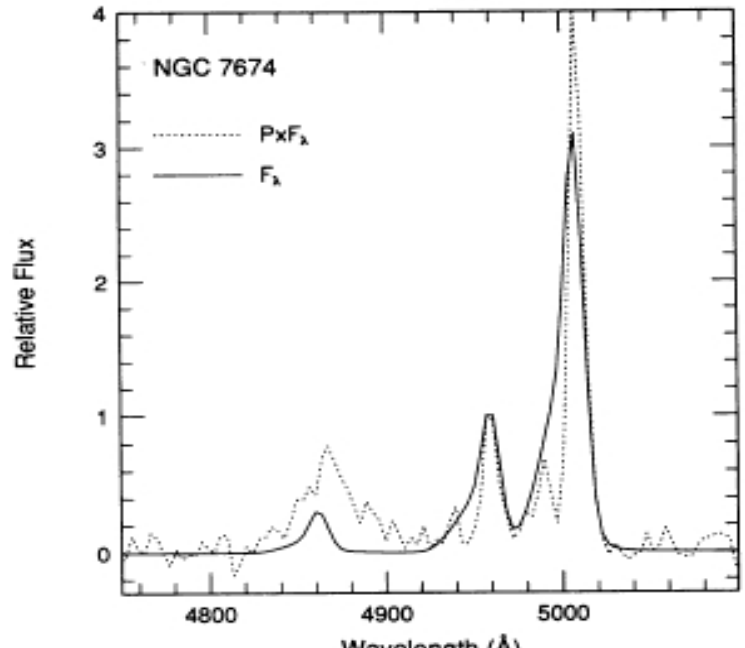
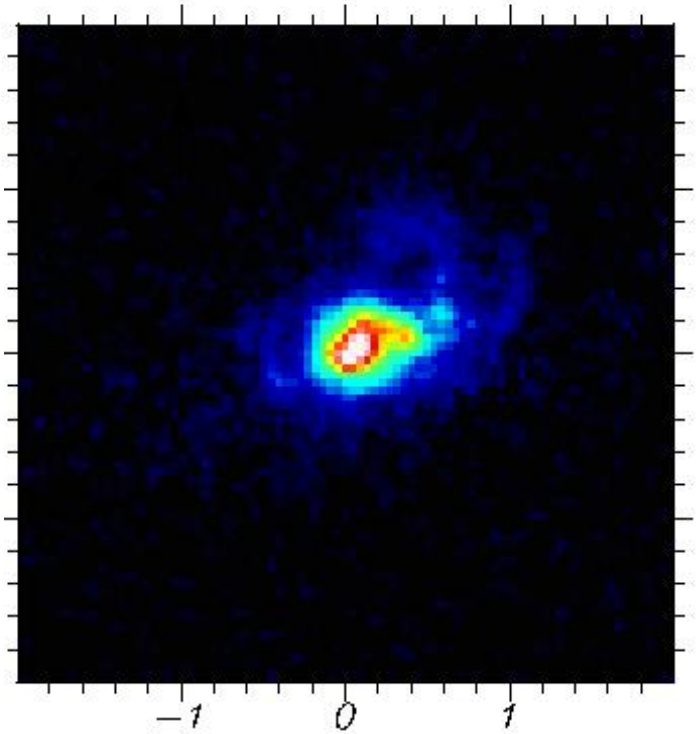
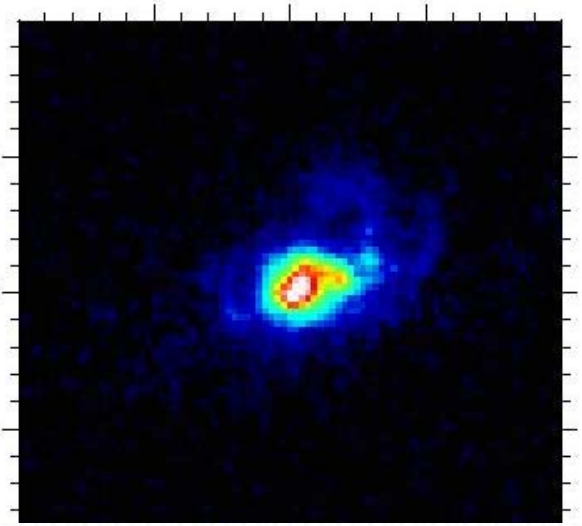

7674
PxF$_\lambda$
F$_\lambda$
Relative Flux
3
2
1
0
4800
4900
5000
Wavelength (Å)

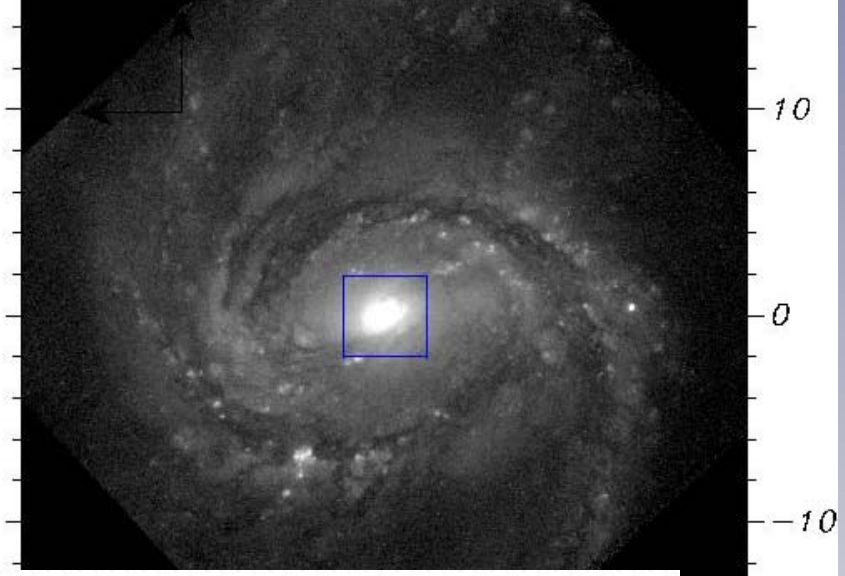


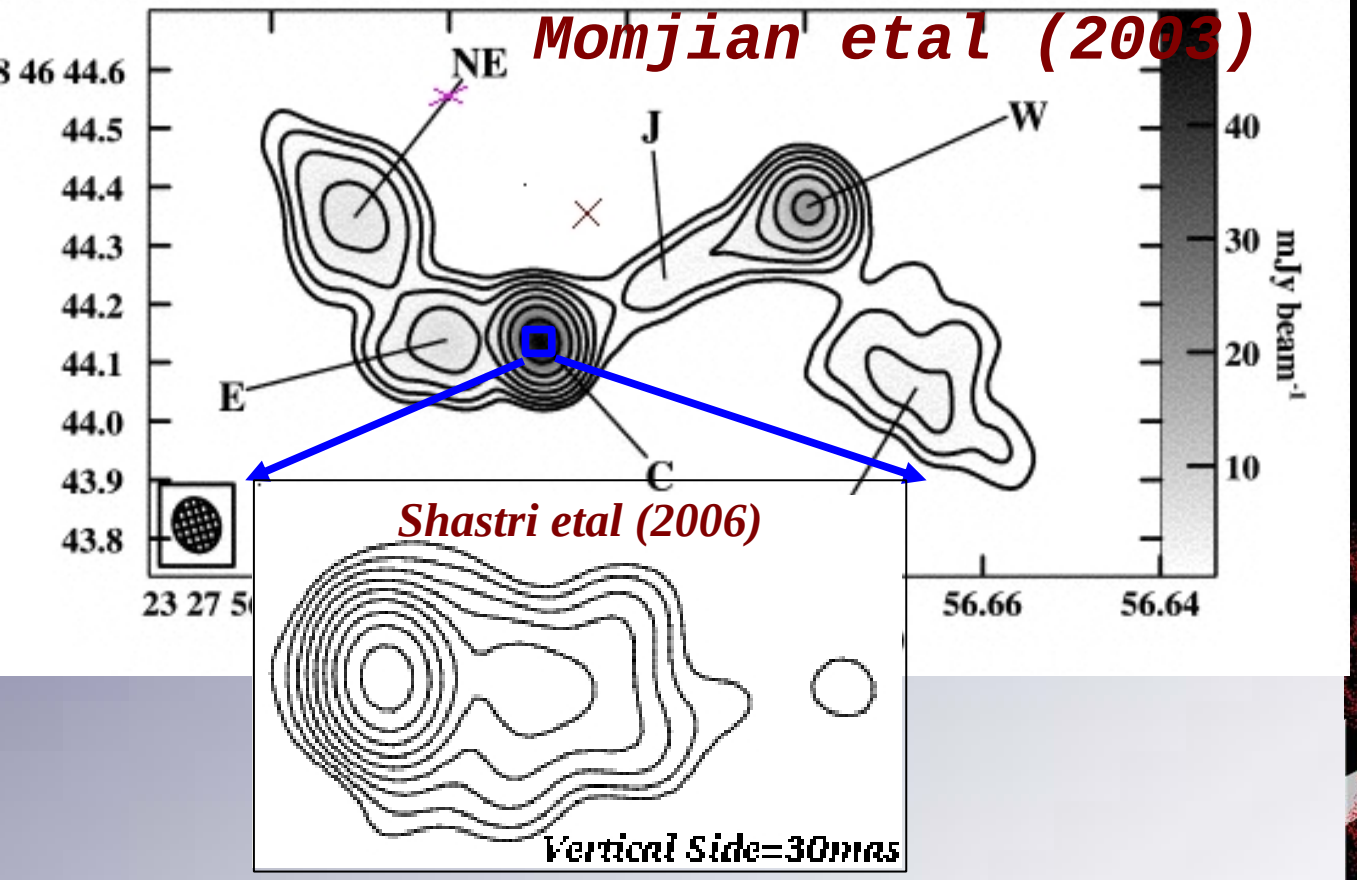
John Hutchings *Herzberg Inst.*
Jayant Murthy
Mark Whittle *Univ. of Virginia*
Beverley J. Wills *Univ. of Texas*
Denise Gabuzda *Univ. College Cork*
Rob Beswick *Jodrell Bank Obs.*

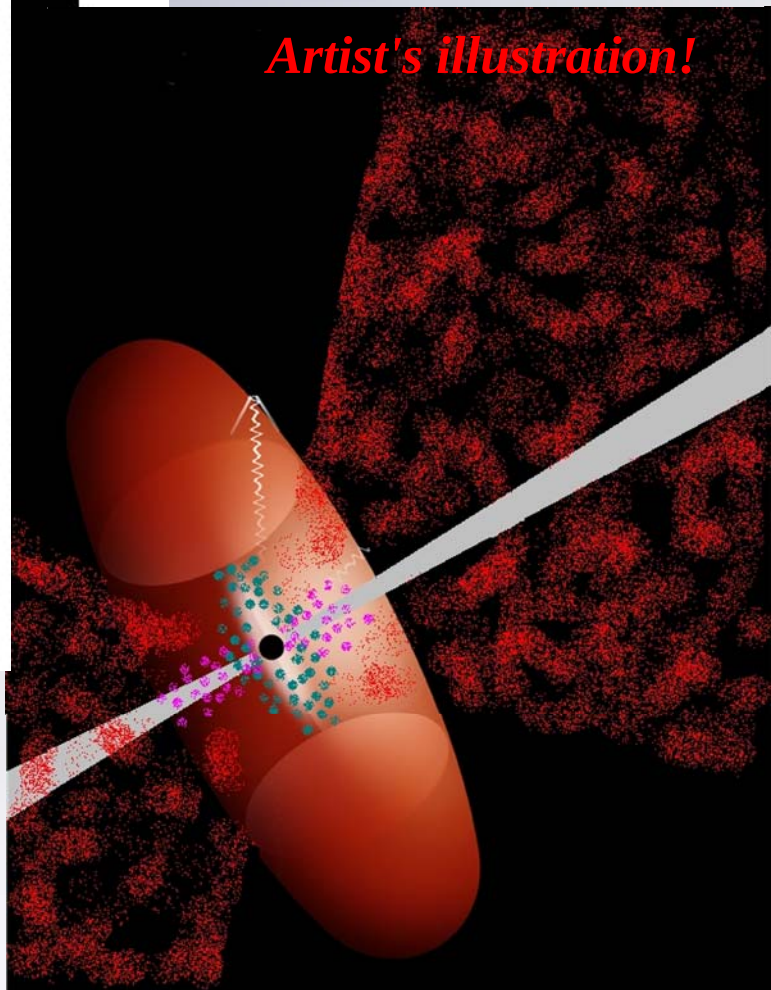







10
0
−10


Momjian etal (2003)
NE
J
W
E
C
44.6
44.5
44.4
44.3
44.2
44.1
44.0
43.9
43.8
56.66
56.64
40
30
20
10
mJy beam^{-1}
Shastri etal (2006)
Vertical Side=30mas


Artist's illustration!

Mrk 533 has a hidden Broad Line Region:

Tran 95

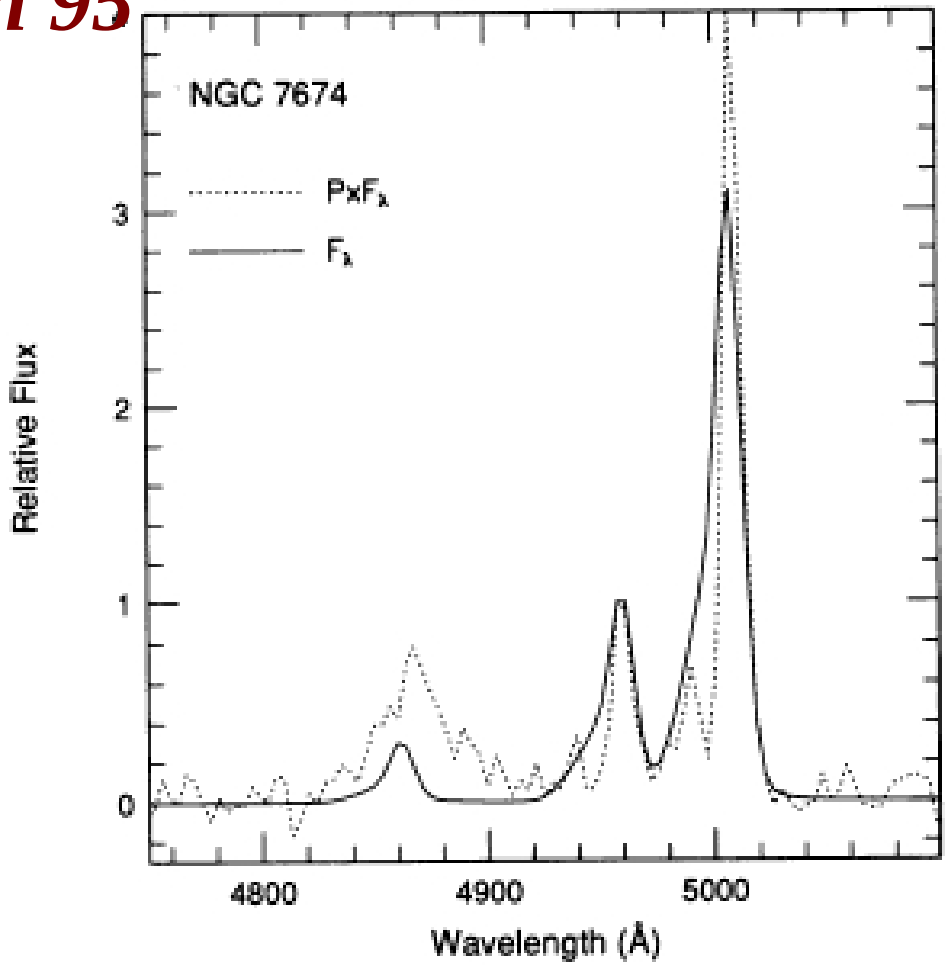
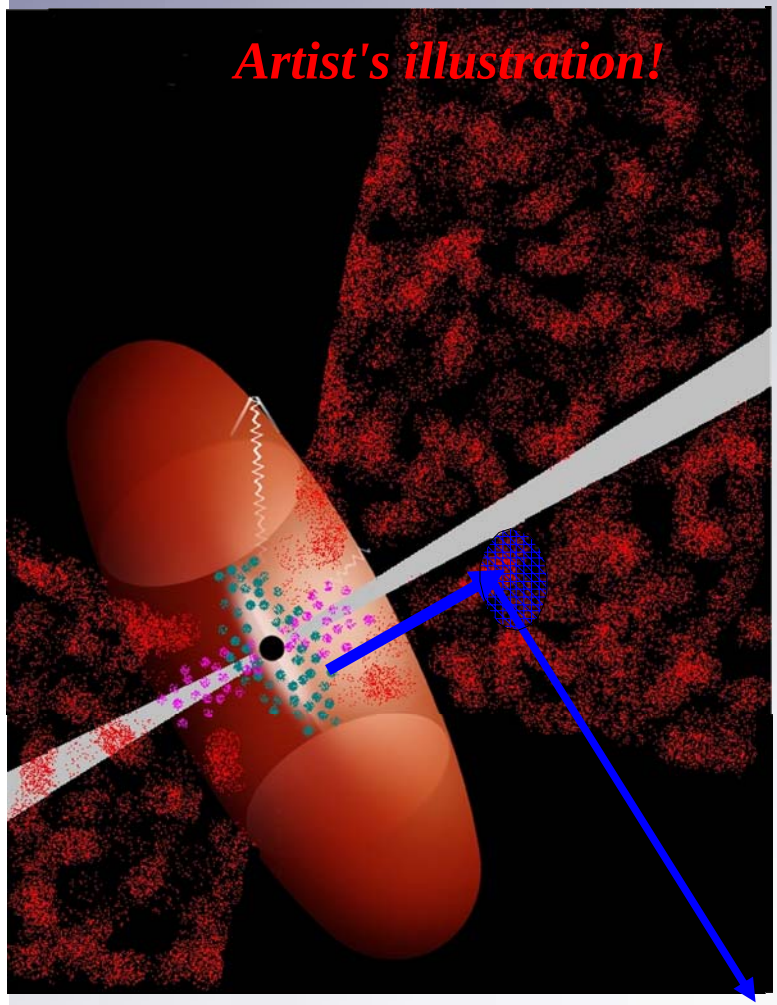
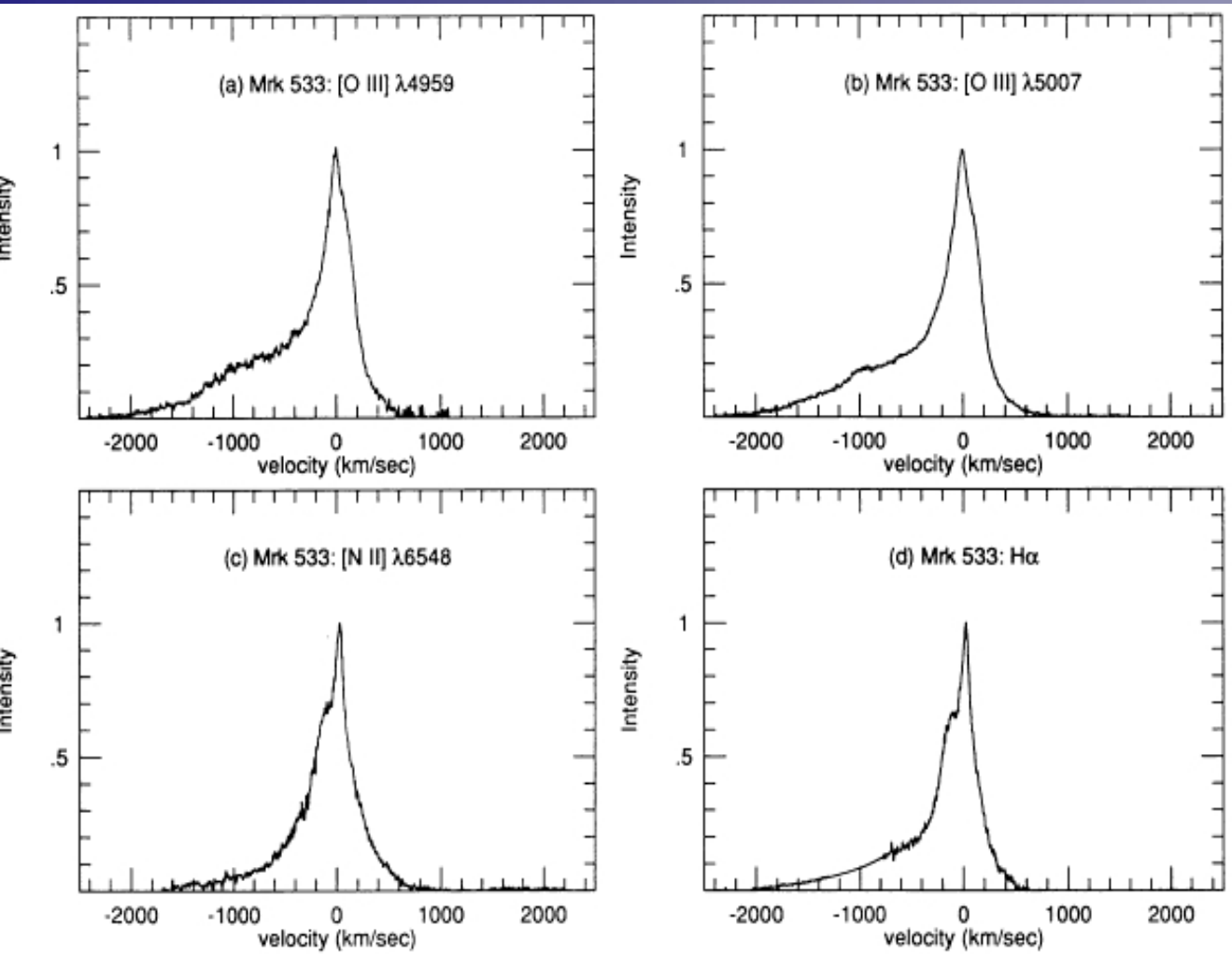
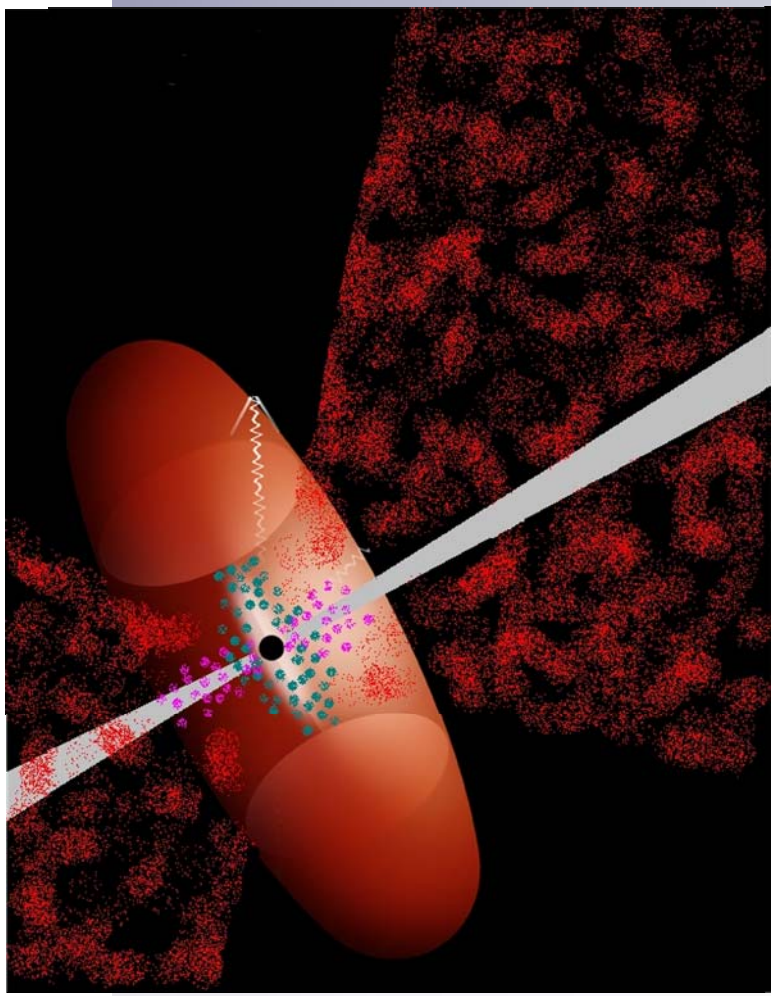


FIG. 13.—Profiles of the [O III] lines in F_λ and $P \times F_\lambda$, normalized at the peak intensity of [O III] λ4959. Note that in $P \times F_\lambda$, the lines are narrower and more symmetric.

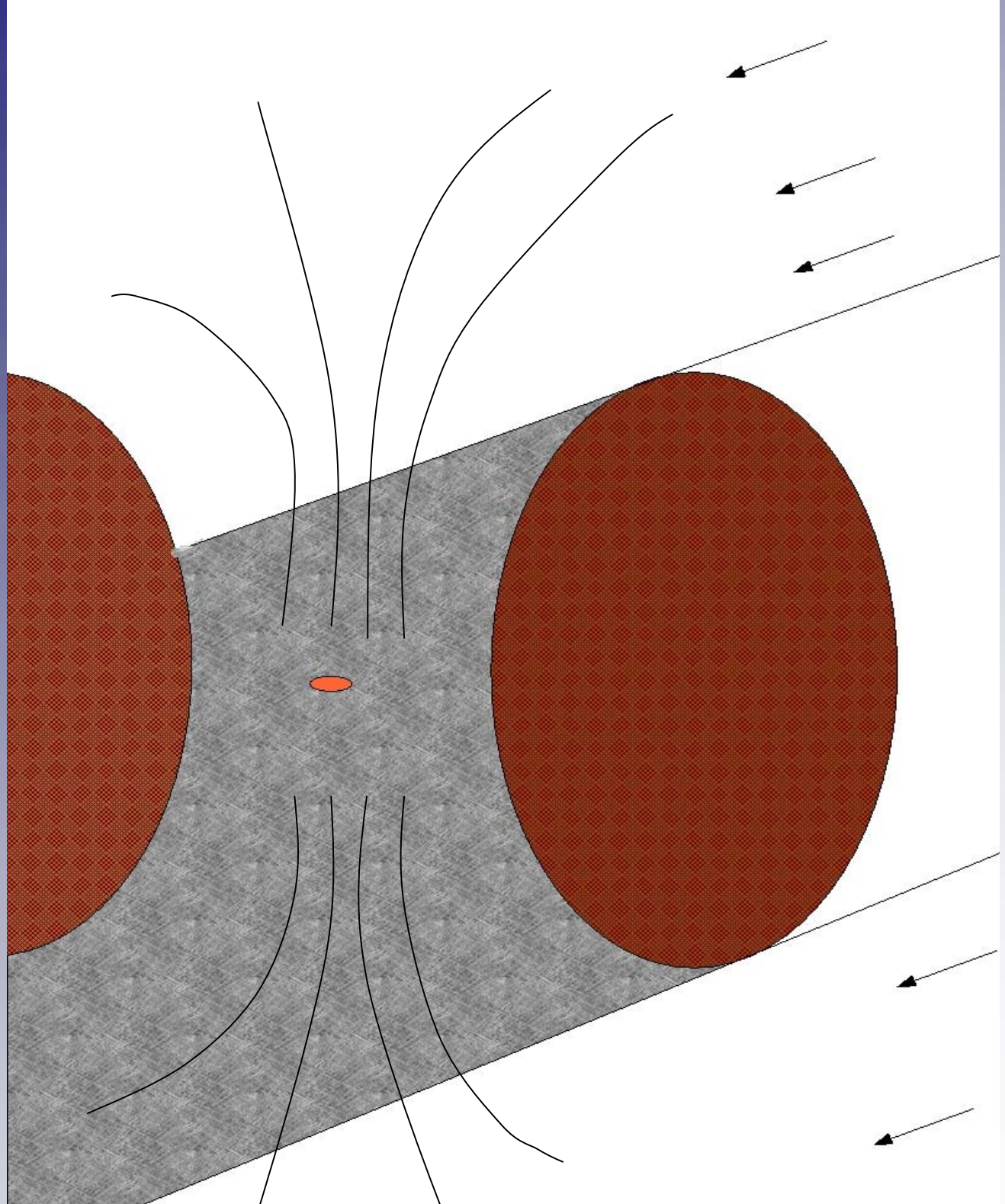


Veilleux 1991





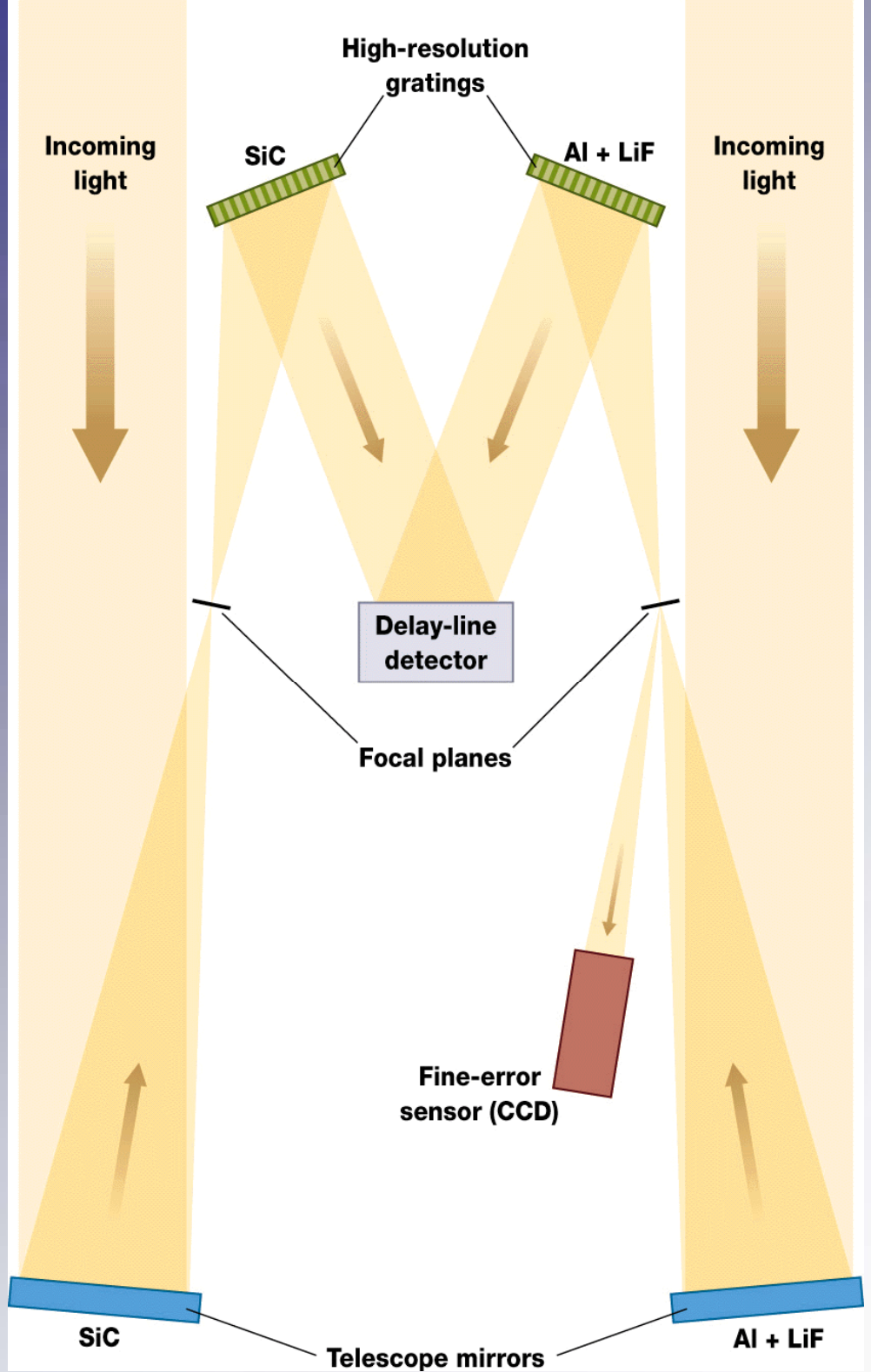
—Narrow emission line profiles of Mrk 533. Method of presentation is the same as in Fig. 1. The origin of the velocity axis corresponds to the ic velocity of the peak of [O III] λ5007: 8728 km s^{-1}.



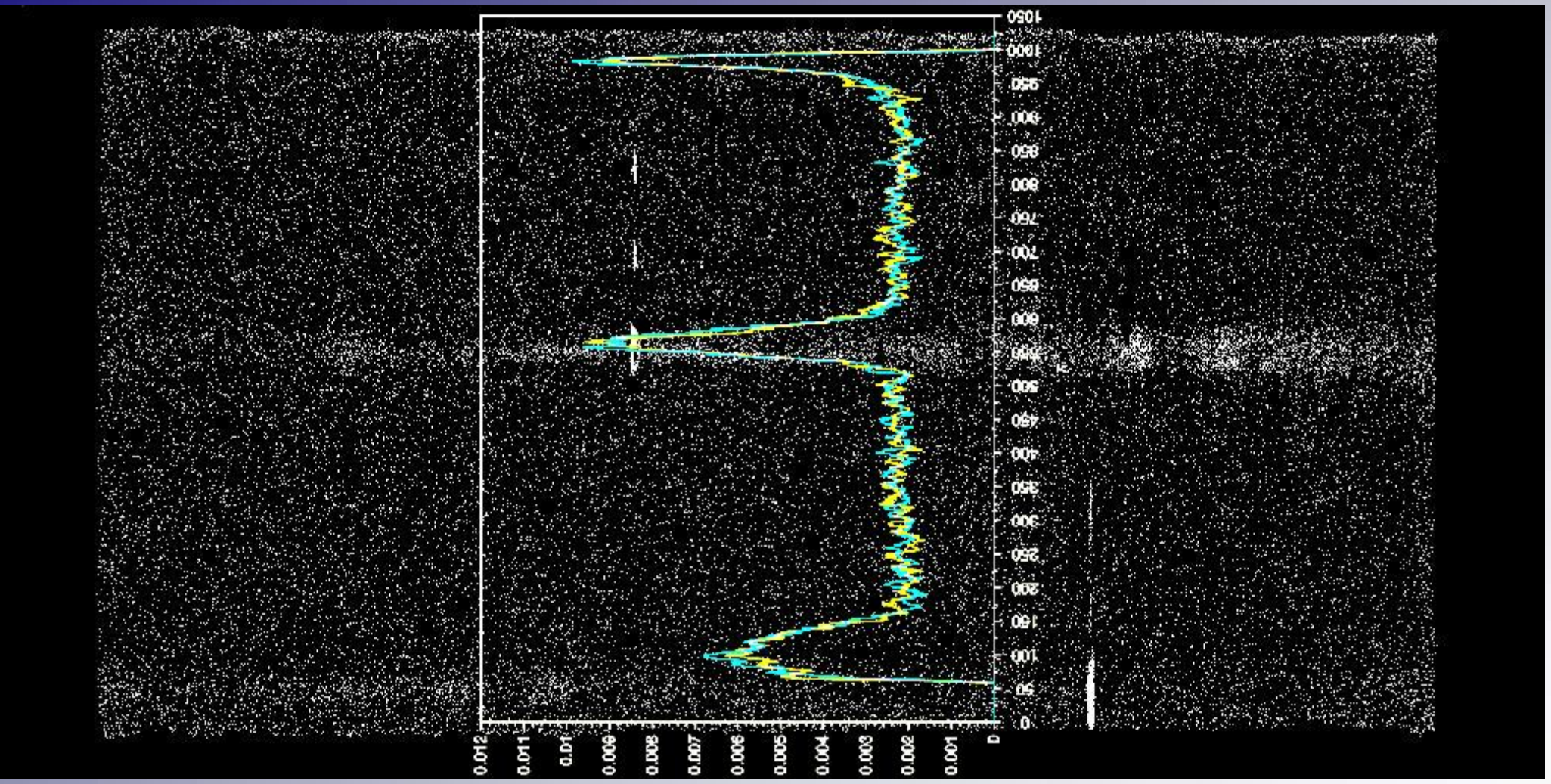
We observed it using FUSE :

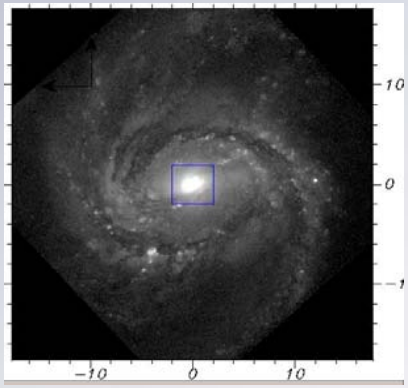
Spectral Resolution:	***~20,000***
Spectral Range:	***900-1200 Angstroms***
Aperture:	***30"x30"***
Two Exposures:	***10.4 ksec, 10.8 ksec***

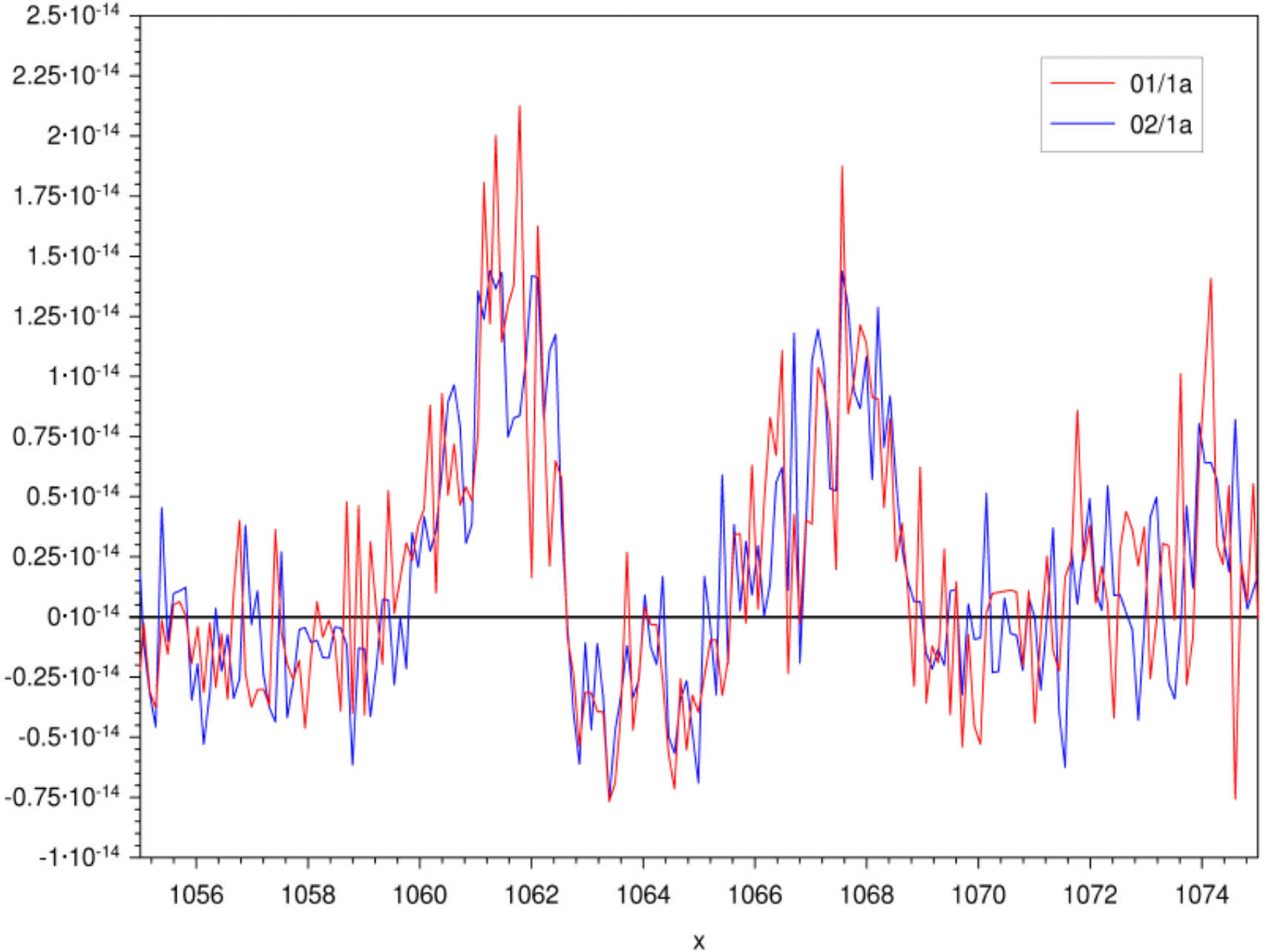
Far-Ultraviolet Spectroscopic Explorer

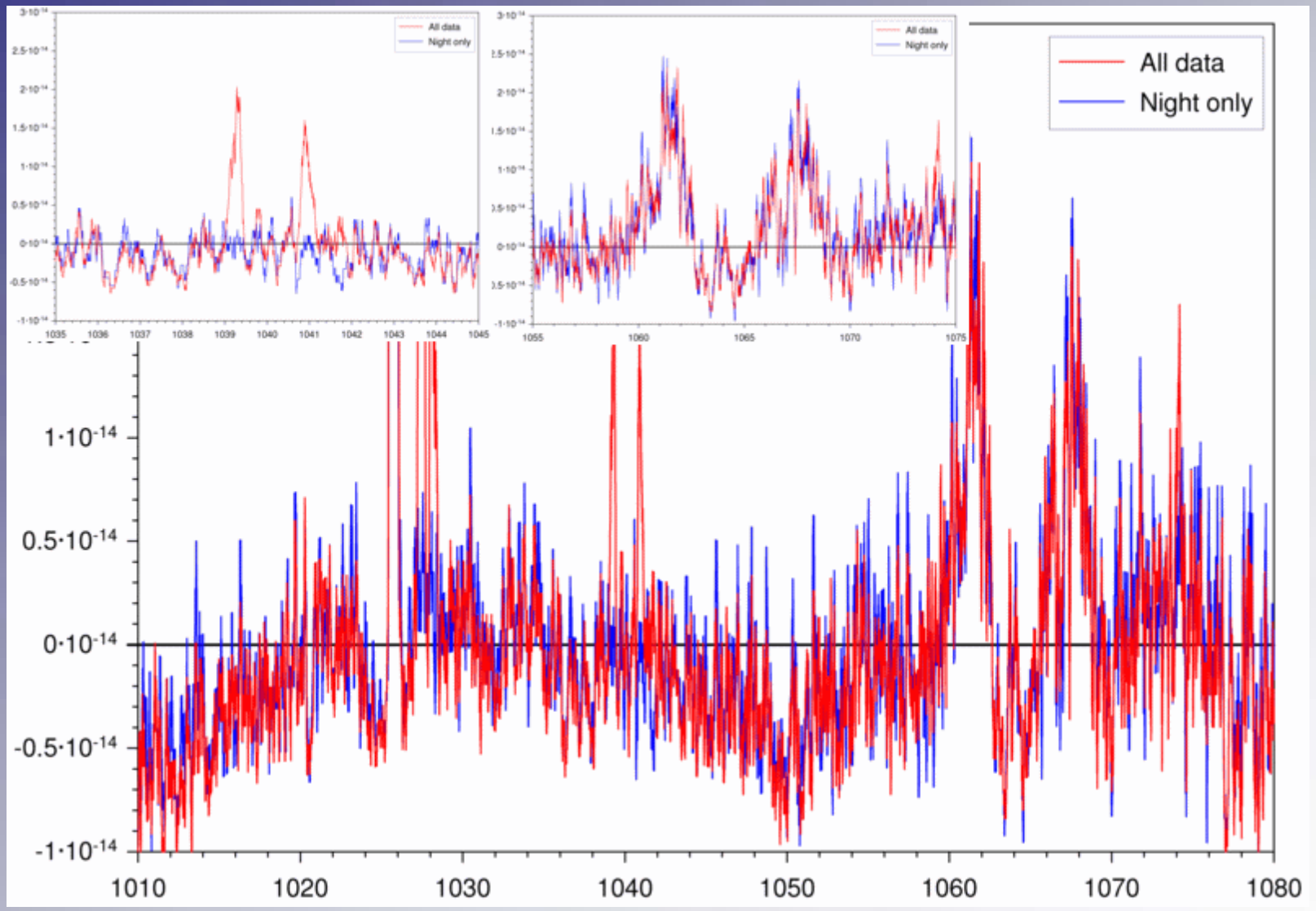

High-resolution gratings
Incoming light
SiC
Al + LiF
Incoming light
Delay-line detector
Focal planes
Fine-error sensor (CCD)
SiC
Telescope mirrors
Al + LiF

Psychotherapy for photon-deficiency syndrome!



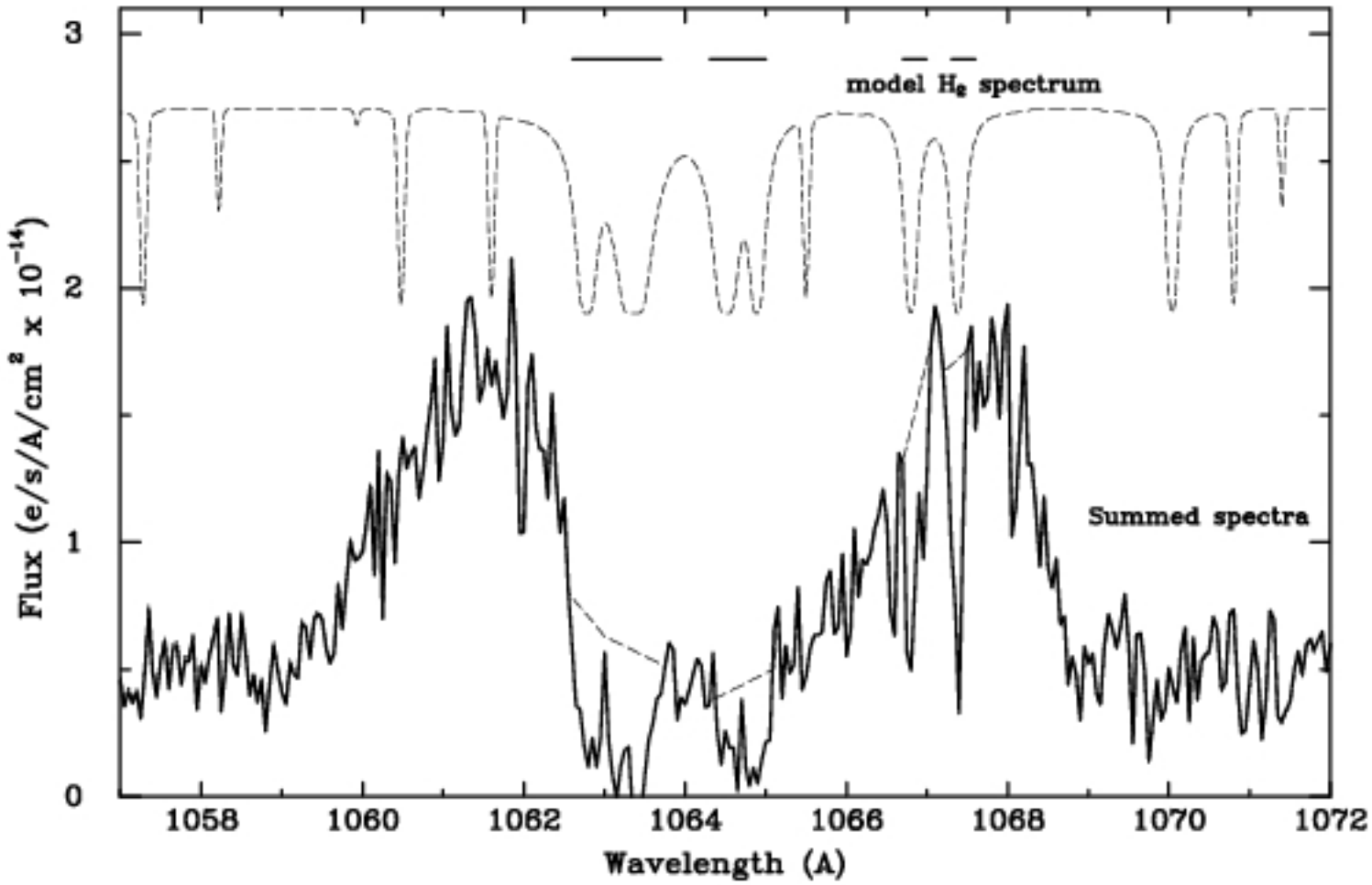


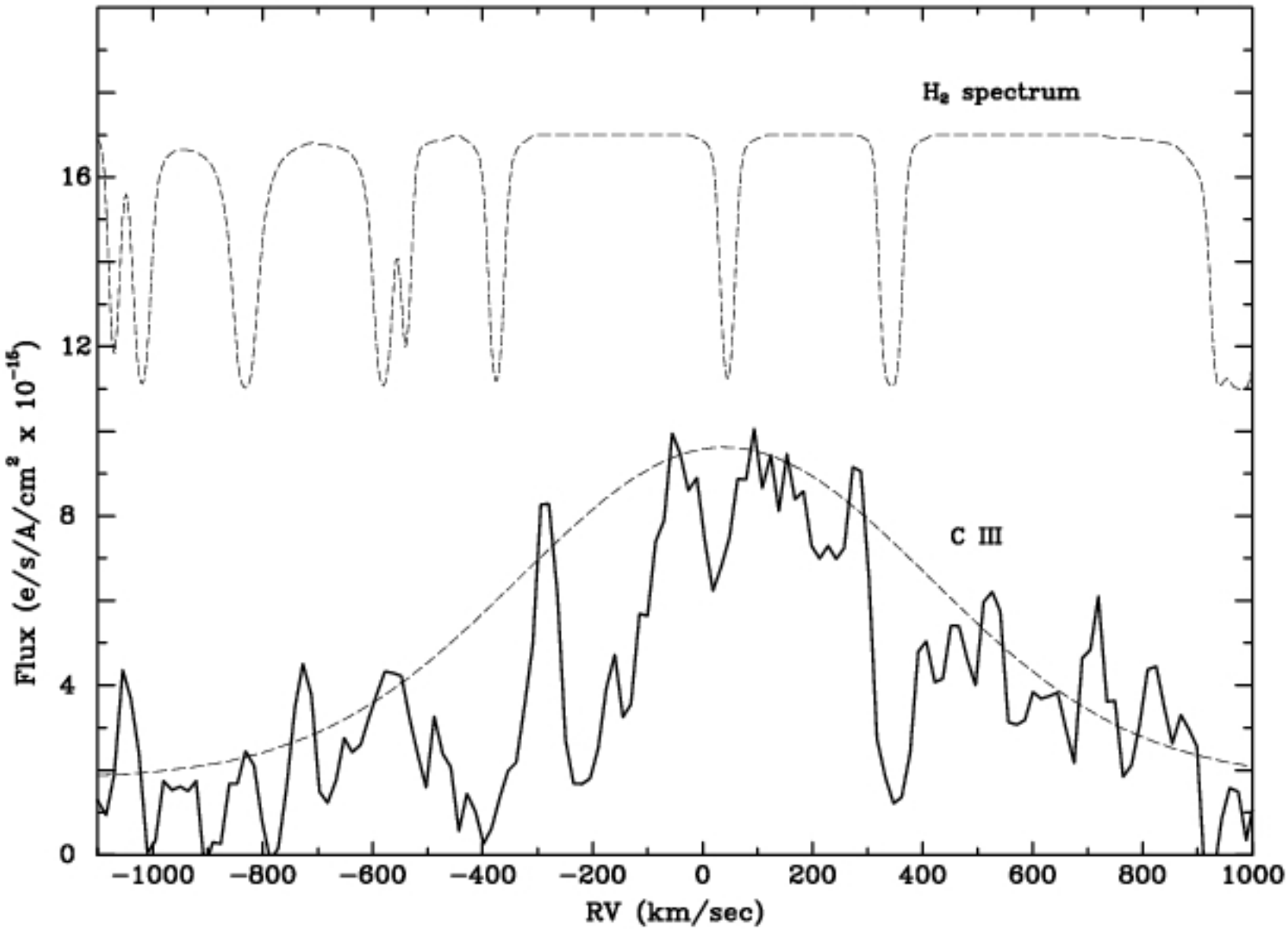

2.5·10-14
2.25·10-14
2·10-14
1.75·10-14
1.5·10-14
1.25·10-14
1·10-14
0.75·10-14
0.5·10-14
0.25·10-14
0·10-14
-0.25·10-14
-0.5·10-14
-0.75·10-14
-1·10-14
1056
1058
1060
1062
1064
1066
1068
1070
1072
1074
x
01/1a
02/1a


All data
Night only
1·10-14
0.5·10-14
0·10-14
-0.5·10-14
-1·10-14
1010
1020
1030
1040
1050
1060
1070
1080

Mrk533

FUSE


model H_2 spectrum
Summed spectra
Flux (e/s/A/cm^2 x 10^{-14})
Wavelength (A)
0
1
2
3
1058
1060
1062
1064
1066
1068
1070
1072


H₂ spectrum
C III
Flux (e/s/A/cm² x 10⁻¹⁵)
RV (km/sec)
0
4
8
12
16
−1000
−800
−600
−400
−200
0
200
400
600
800
1000

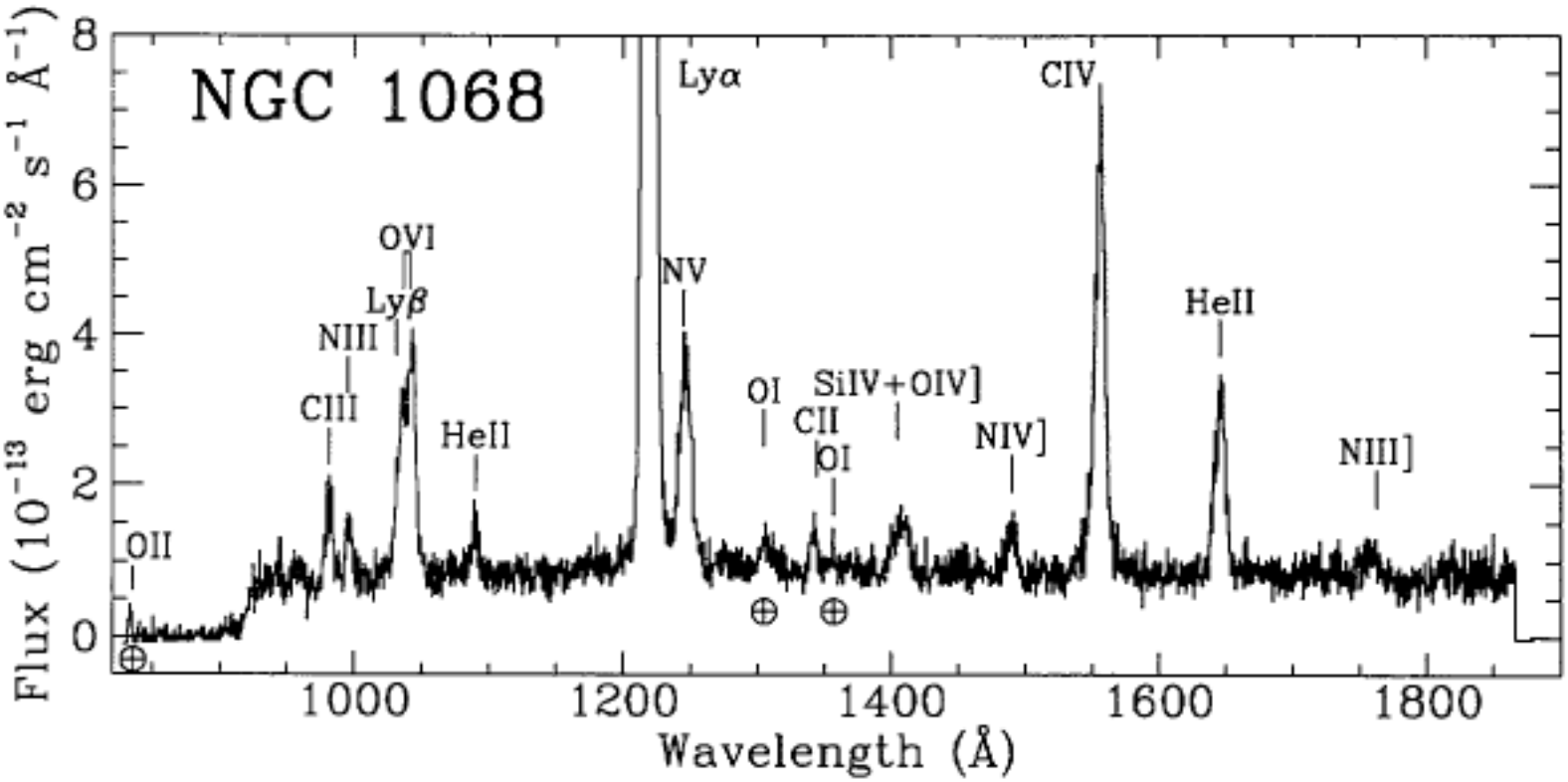
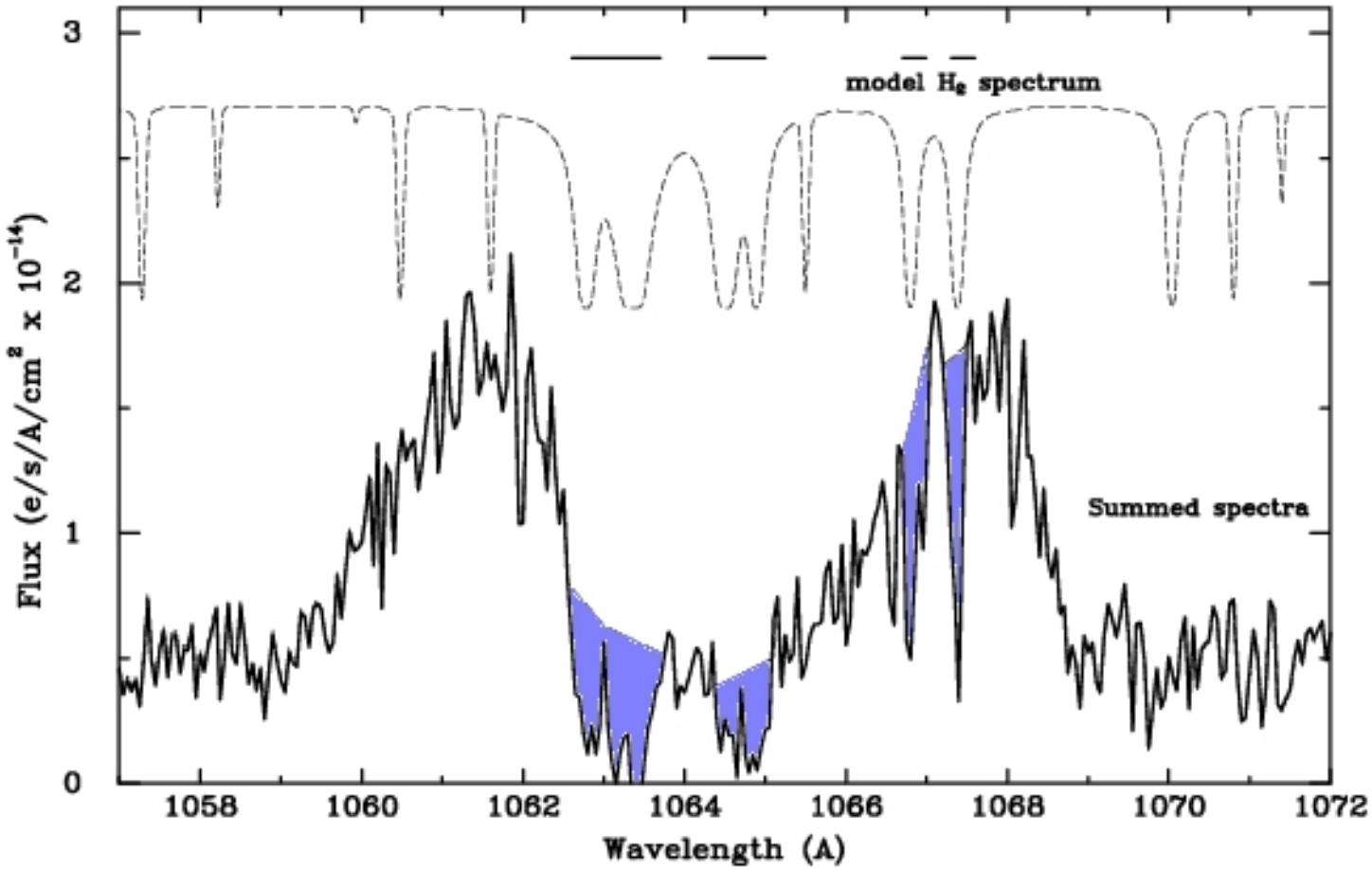


FIG. 2.—The flux-calibrated HUT spectrum of NGC 1068 as observed through the 18" aperture. Prominent emission lines are marked, and airglow emission is indicated with an Earth symbol. Lyα from NGC 1068 is blended with geocoronal Lyα and is off scale in the figure. Of particular note in the region below Lyα are the strong emissions from C III λ977, N III λ991, Lyβ, O VI λλ1032, 1038, and He II λ1085.

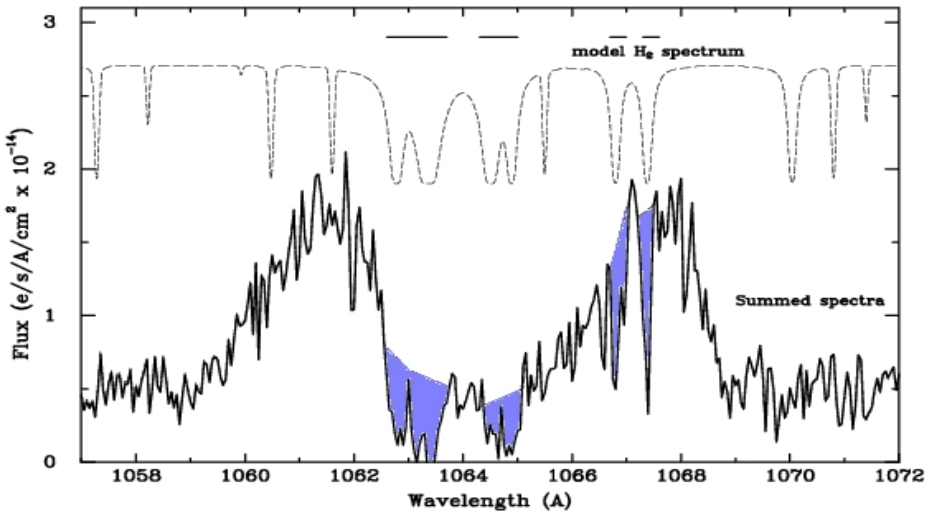
Shastri et al (2006)

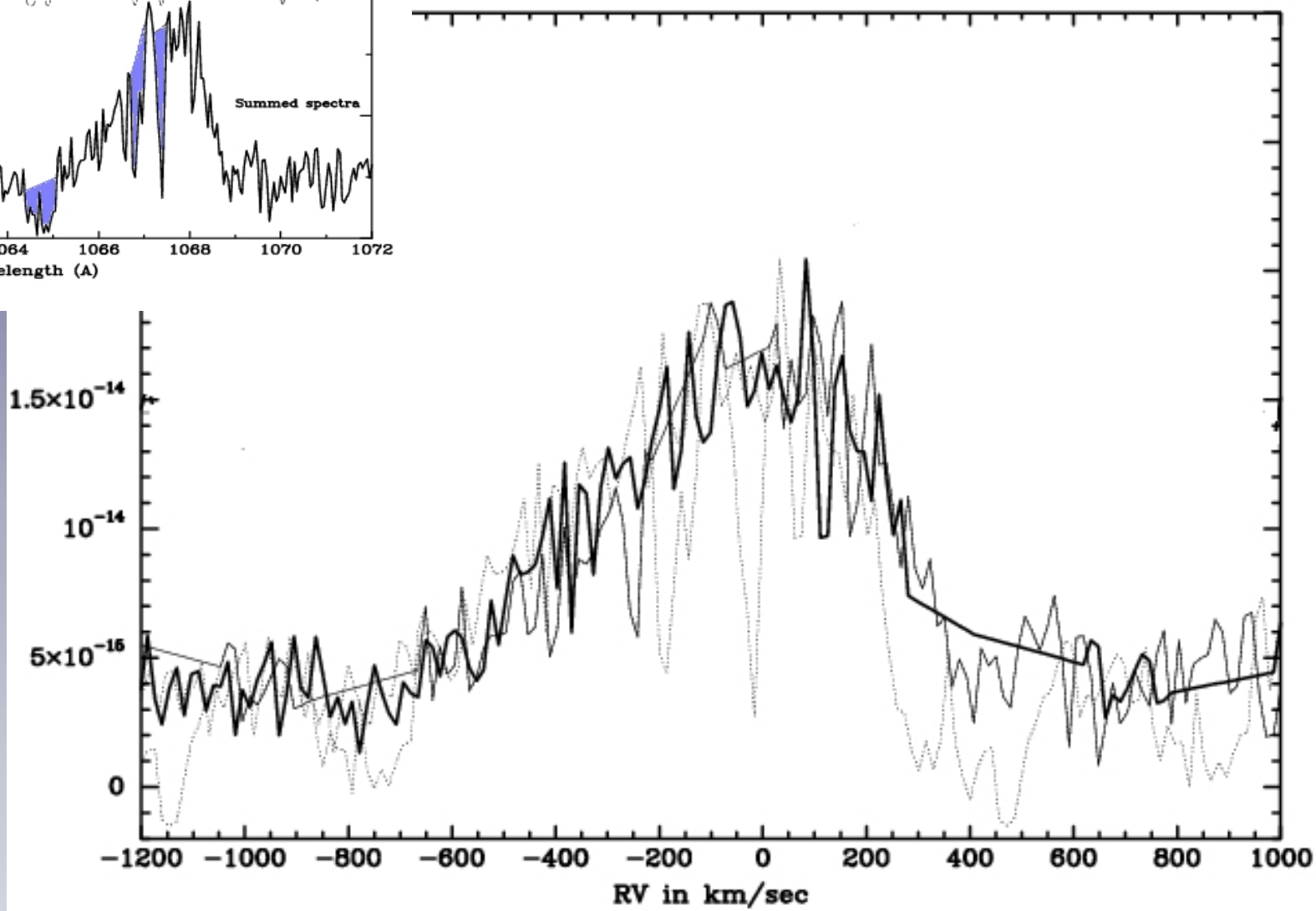
Mrk533

FUSE

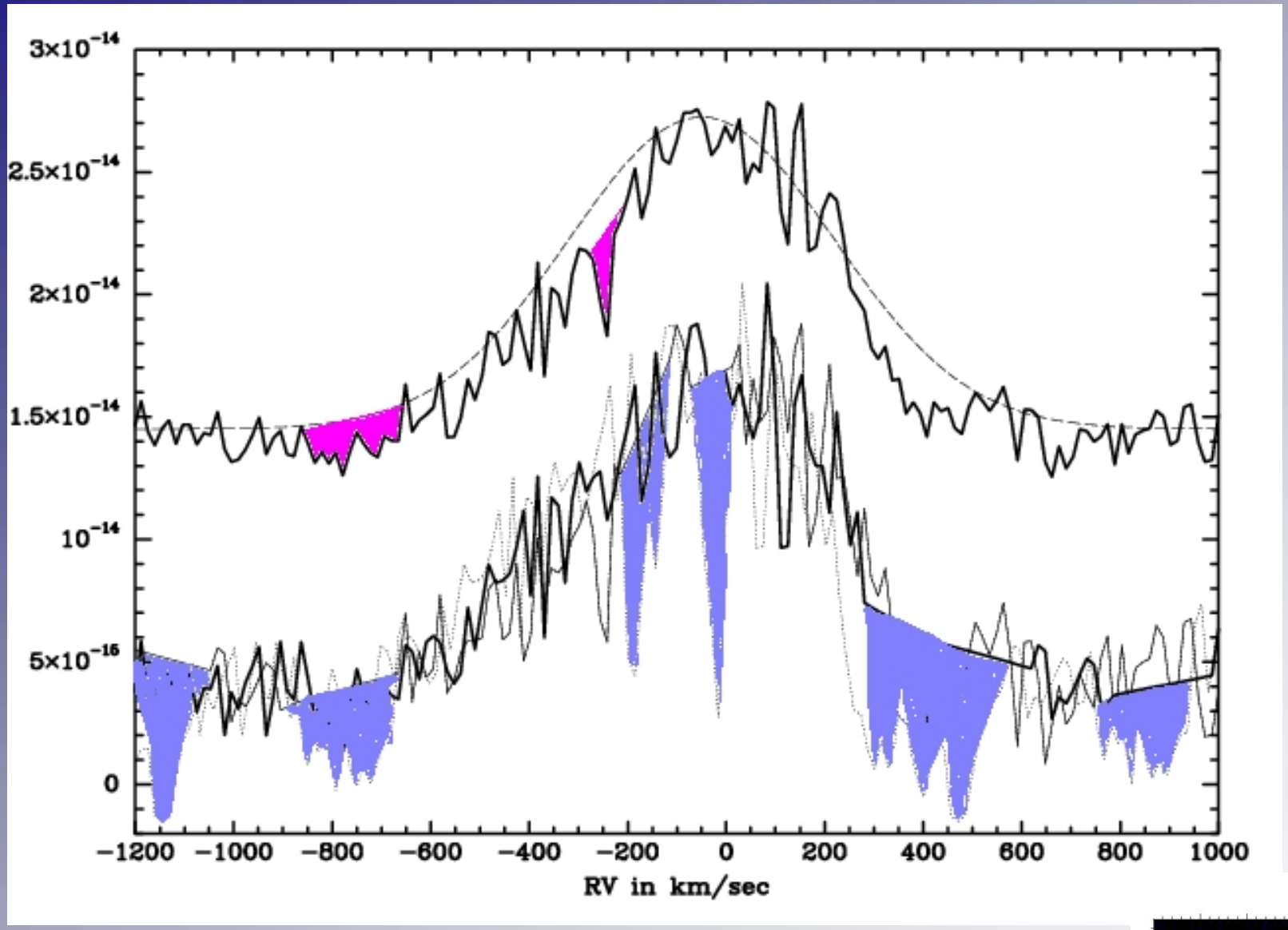


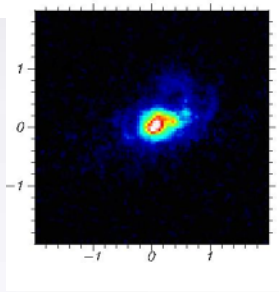
Mrk533 *Shastri et al 06* FUSE

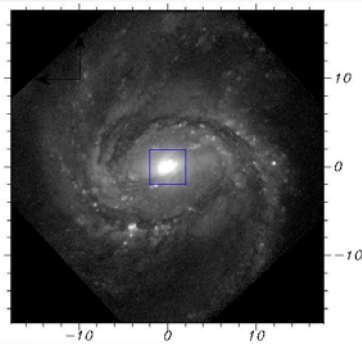


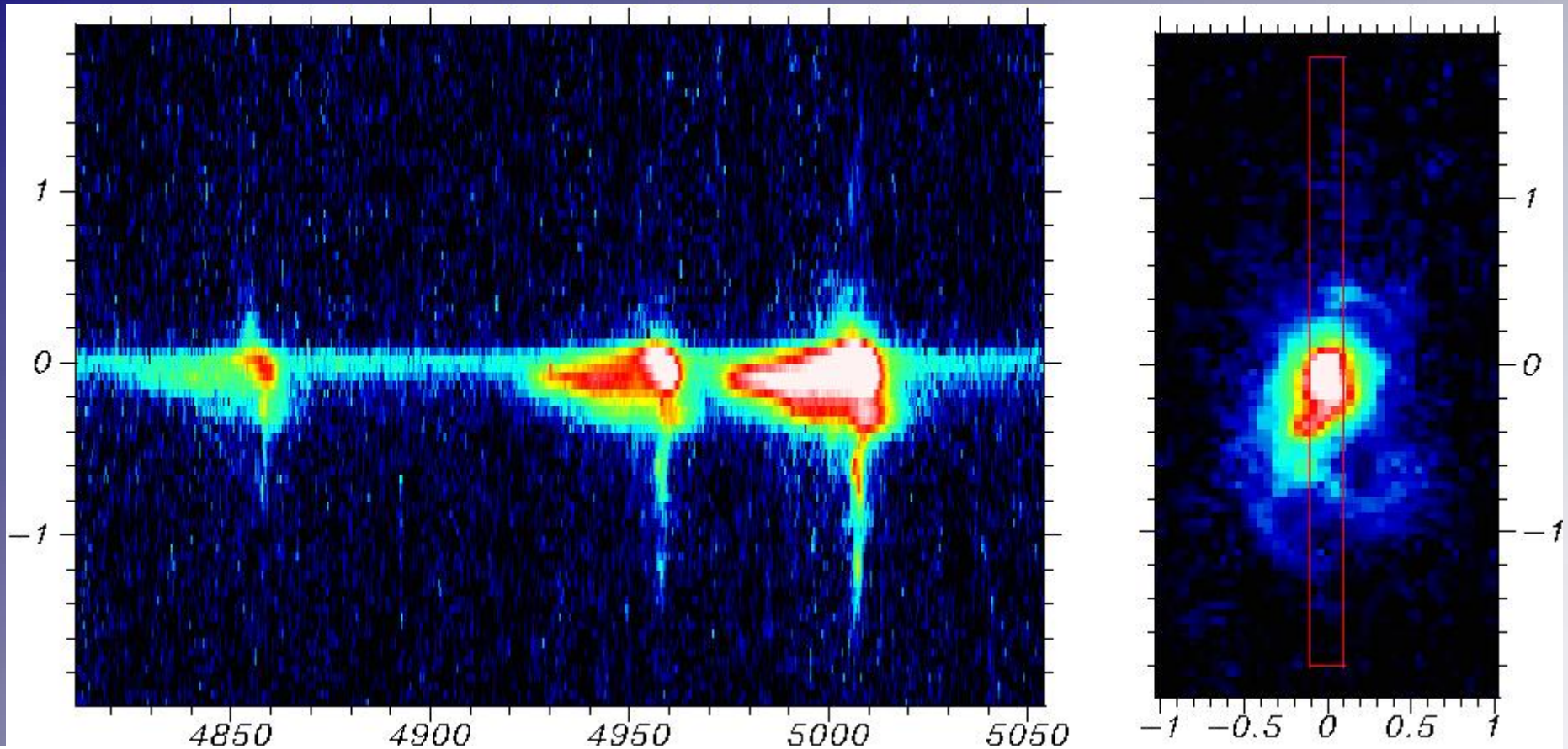


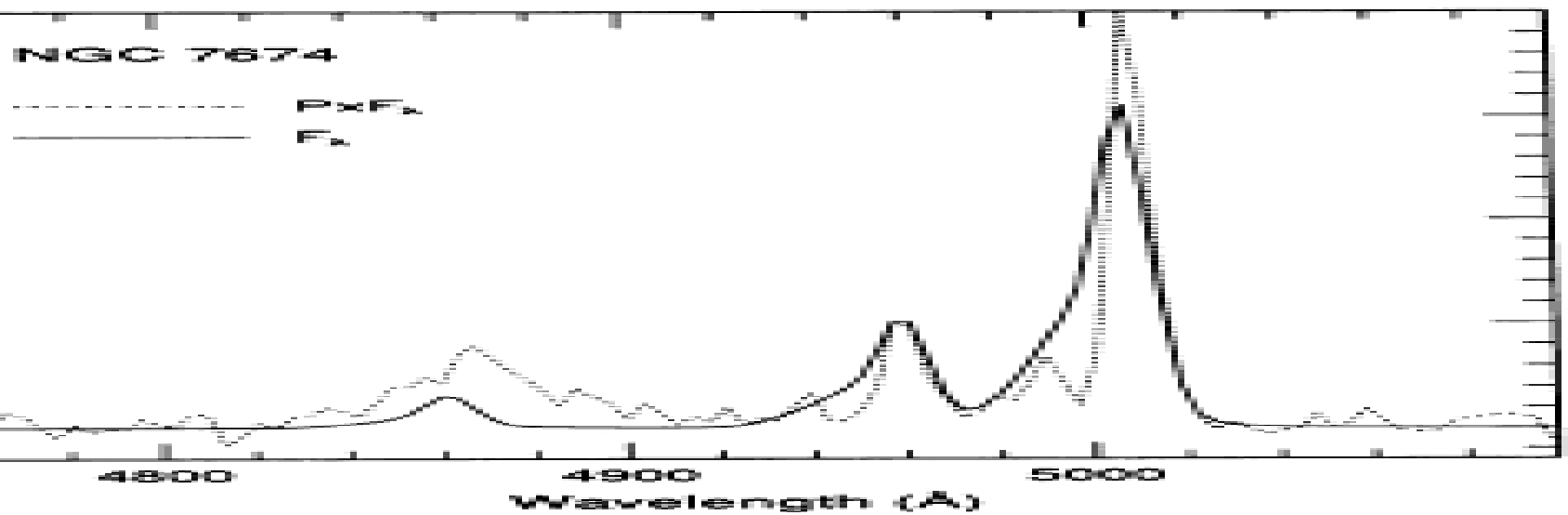
Mrk533 *Shastri et al 06* FUSE





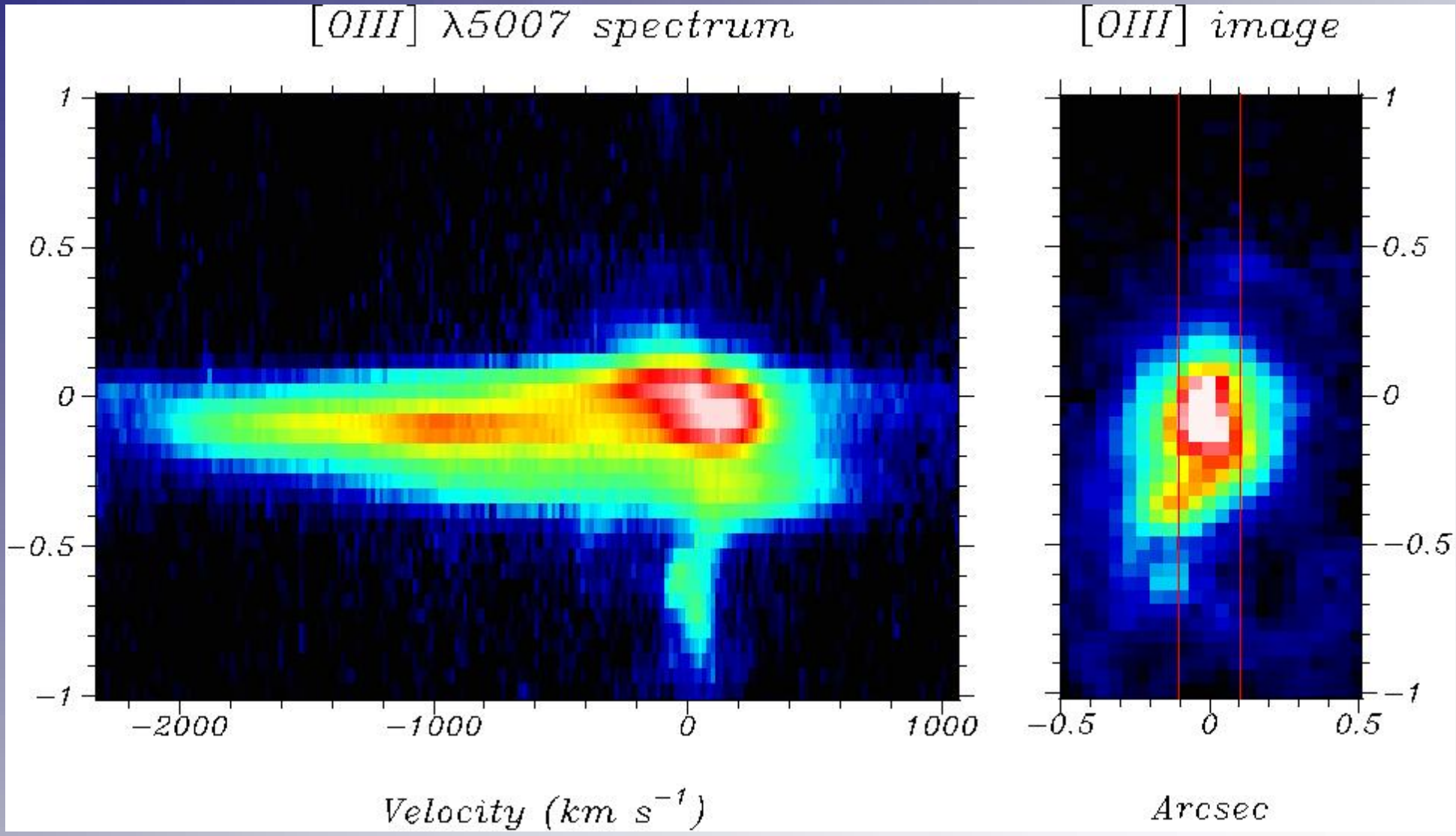


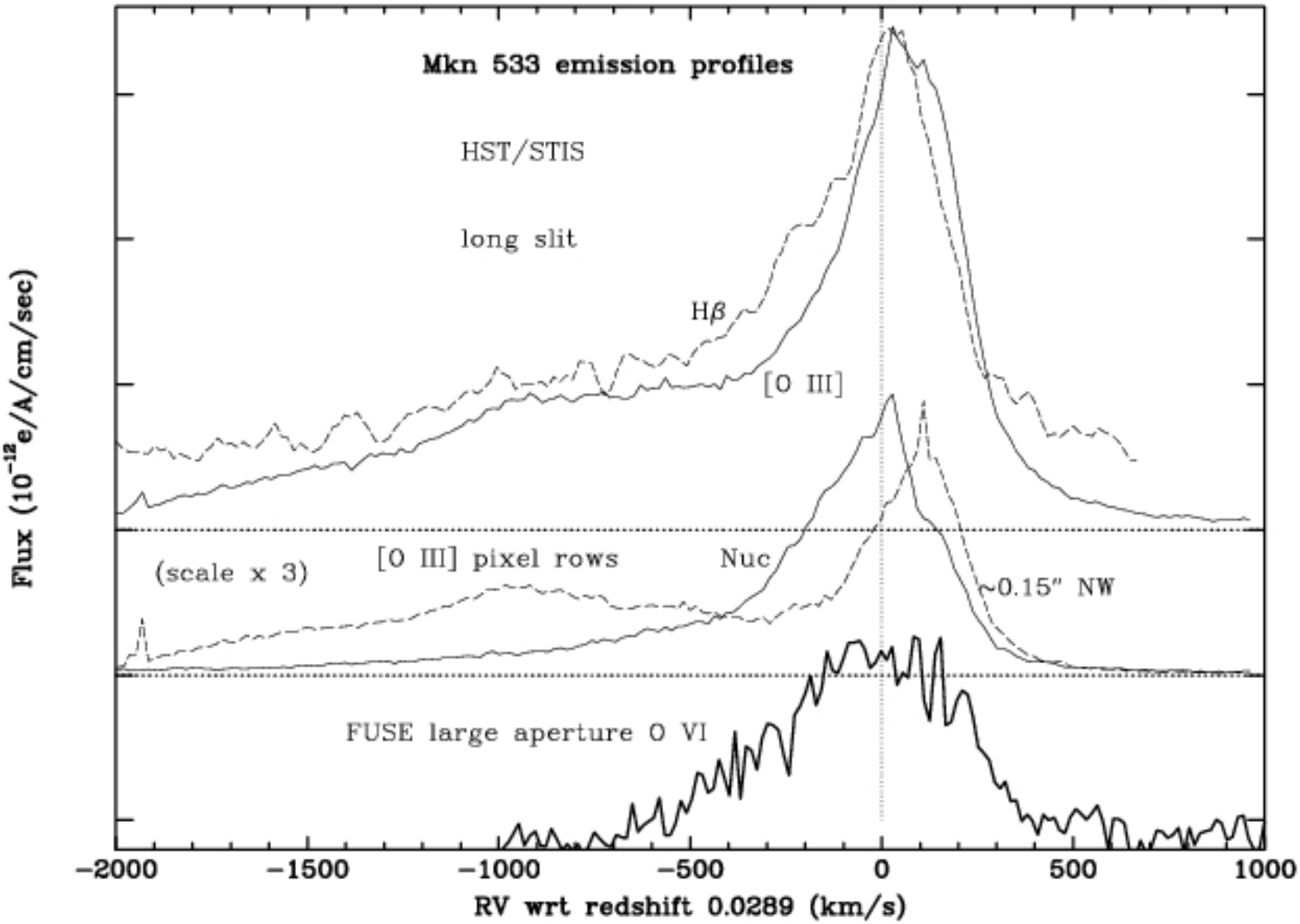




iles of the [O III] lines in F_λ and $P \times F_\lambda$, normalized at the
O III] λ4959. Note that in $P \times F_\lambda$, the lines are narrower and

Shastri et al (2006)




Mkn 533 emission profiles
HST/STIS
long slit
Hβ
[O III]
(scale x 3)
[O III] pixel rows
Nuc
~0.15" NW
FUSE large aperture O VI
Flux (10^{-12}e/A/cm/sec)
−2000
−1500
−1000
−500
0
500
1000
RV wrt redshift 0.0289 (km/s)

De Robertis & Shaw 1990

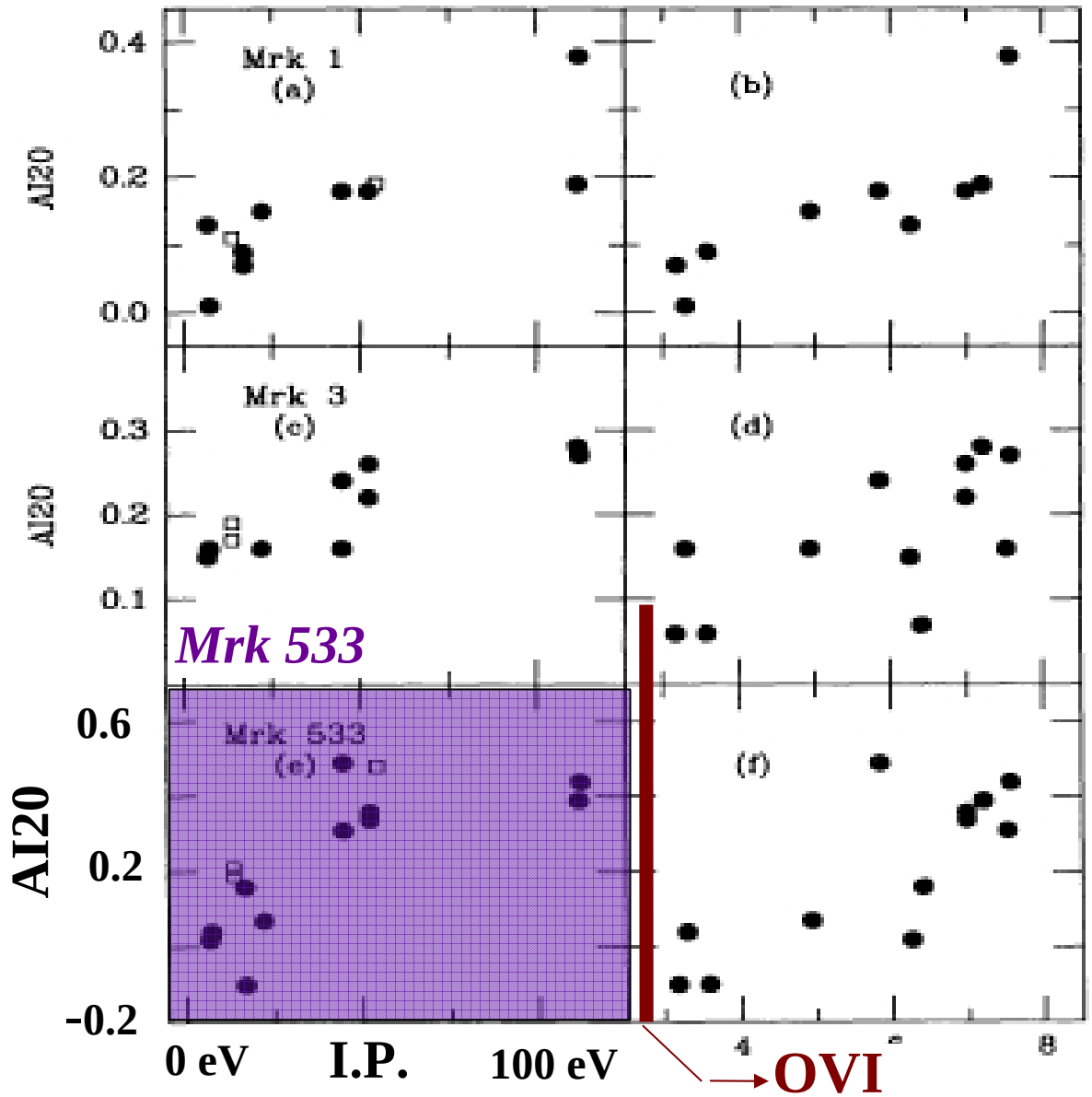
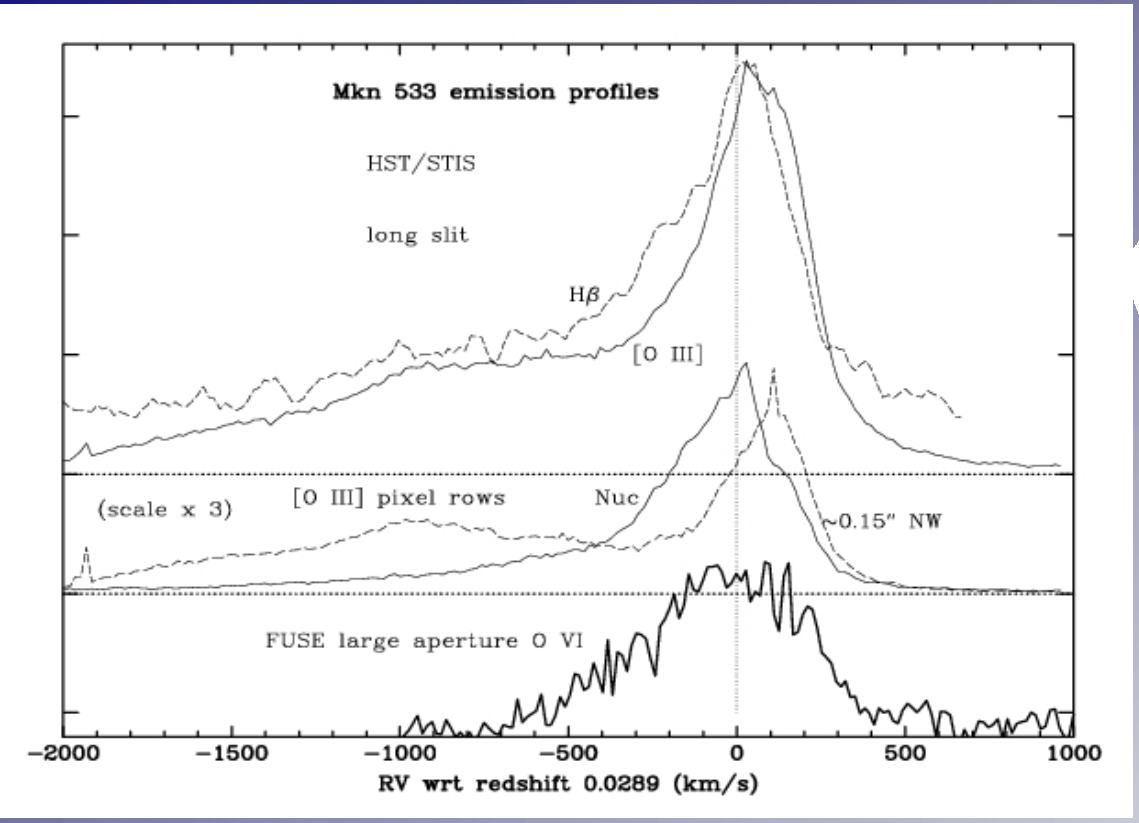
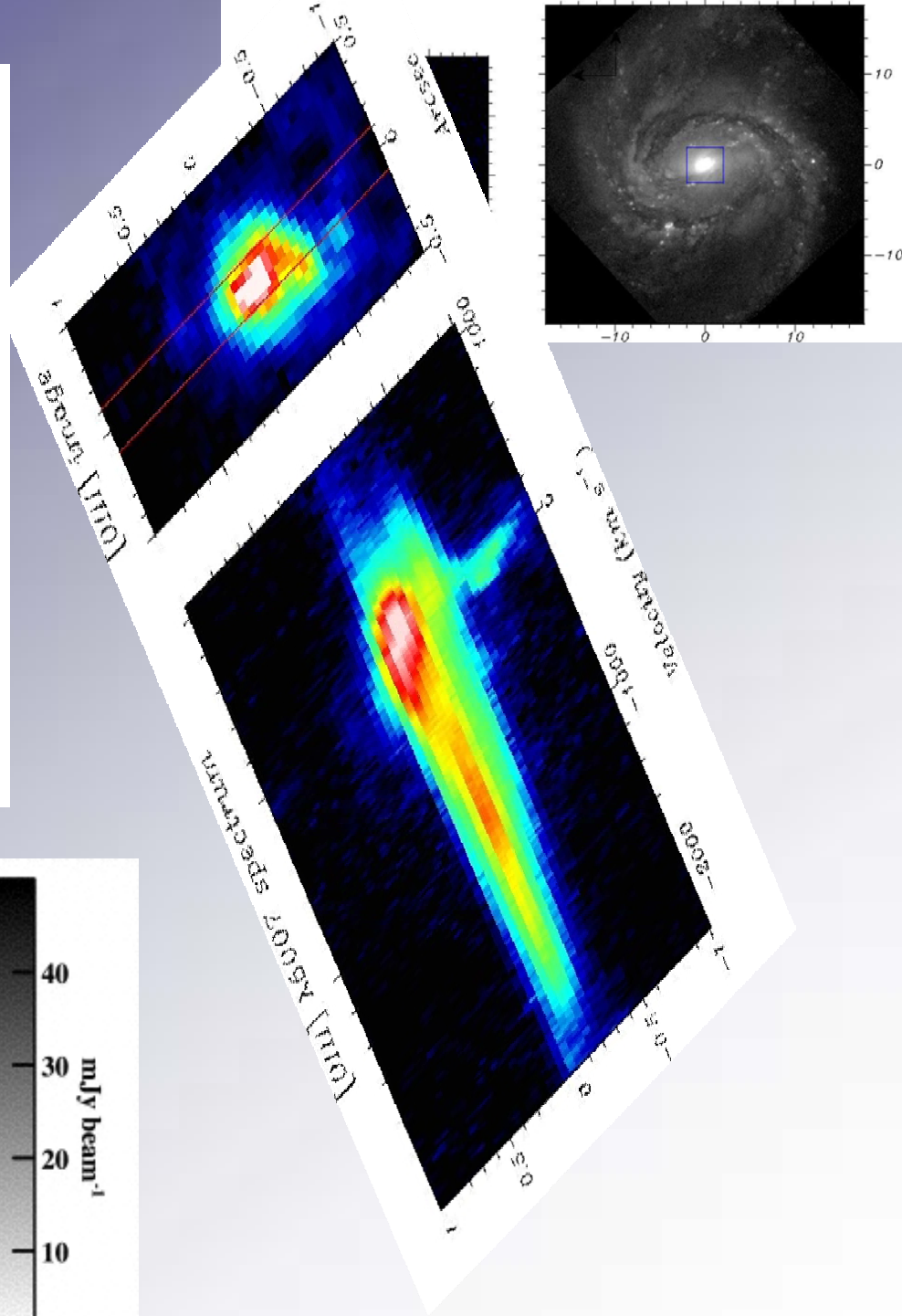
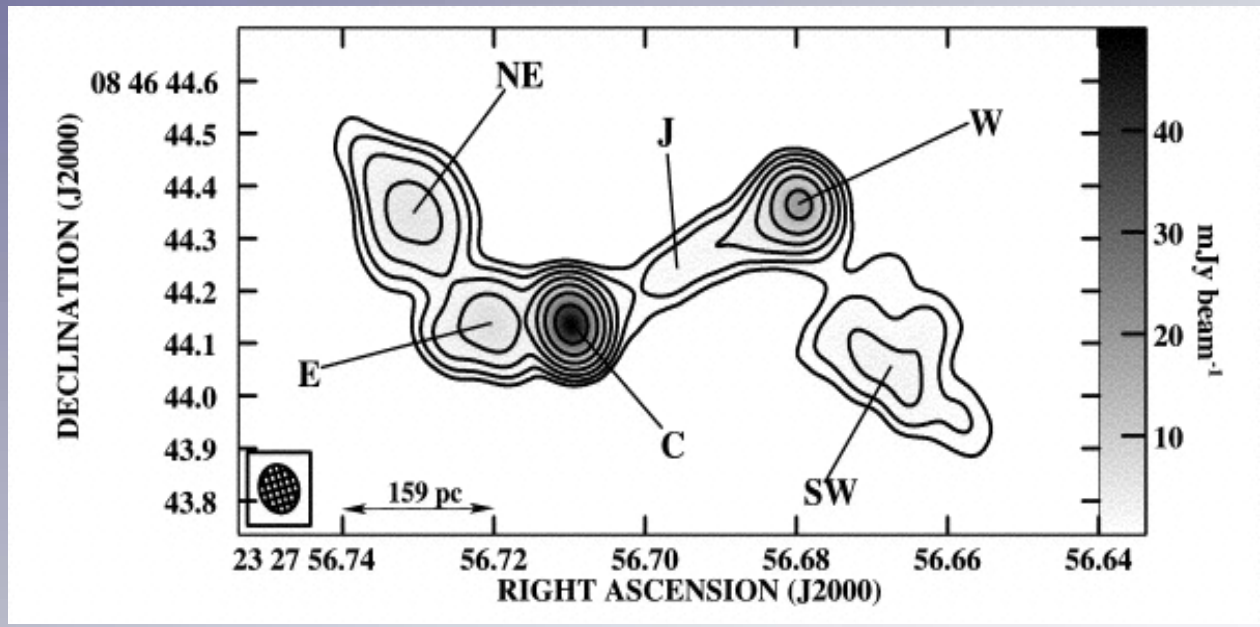


FIG. 2.—Plots of mean IP and log N_{cr} vs. line asymmetry, AI20, for Mrk 1 (*a*, *b*), Mrk 3 (*c*, *d*), and Mrk 533 (*e*, *f*). Open circles indicate less certain [O II] λ3727 results (see text), and open squares denote H and He recombination lines.


Mkn 533 emission profiles
HST/STIS
long slit
Hβ
[O III]
(scale x 3)
[O III] pixel rows
Nuc
~0.15" NW
FUSE large aperture O VI
−2000
−1500
−1000
−500
0
500
1000
RV wrt redshift 0.0289 (km/s)


[OIII] image
[OIII] 5007 spectrum
Relative (km s⁻¹)
ARCSEC


NE
J
W
E
C
SW
159 pc
08 46 44.6
44.5
44.4
44.3
44.2
44.1
44.0
43.9
43.8
DECLINATION (J2000)
23 27 56.74
56.72
56.70
56.68
56.66
56.64
RIGHT ASCENSION (J2000)
40
30
20
10
mJy beam⁻¹

Our Results:

We find that the high-velocity component of the hot gaseous outflow in an obscured Seyfert galaxy is ionized enough that it emits the high excitation OVI 1032,1038 emission line doublet

The CIII977 emission line is also weakly detected

As expected, Galactic molecular hydrogen produces contaminating absorption features

The OVI emission line has a relatively "narrow“ FWHM of <1000km/s in predicted contrast to the OVI emission line seen in purportedly pole-on Seyferts

We see a blue wing to the OVI line profile

Contrary to what might be expected, however, this line is less asymmetric, i.e., ''less blue'', than the lower-ionization [OIII] emission line contrary to the DeRobertis-Shaw correlation for Mrk 533

From the spectroscopic image it is clear that the blue wing is from an approaching outflow

The difference between the OVI and [OIII] profiles is consistent with mild outflow with the receding part hidden from view.

Beyond this inner region, the gas is strongly accelerated by a nuclear wind or jet flow

The absence of OVI emission in the highly accelerated [OIII]-emitting gas argues in support of this gas being photoionized rather than shock-ionized.

The End