The Warm Ionized Medium

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RADIOPHYSICS

Spectrum of the Galactic Radio Emission between 10 Mc/s and 1·5 Mc/s

As part of a general investigation of cosmic radio noise at frequencies less than 10 Mc/s the intensity of the radiation has been measured at 9·8 Mc/s, 4·8 Mc/s, 2·3 Mc/s and 1·5 Mc/s. The observations were made at Hobart during July and August in 1961 and 1962.

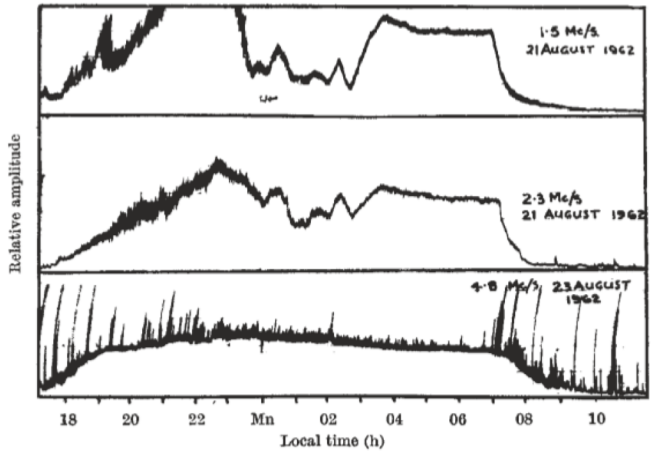

Fig. 1. Sample records of cosmic radio noise at 1·5 Mc/s, 2·3 Mc/s and 4·8 Mc/s. The first two records illustrate the effects of transmitter interference from 1900 to 2400 h and ionospheric modulation from 2400 h to 0300 h. The galactic profile appears from 0400 h to 0700 h

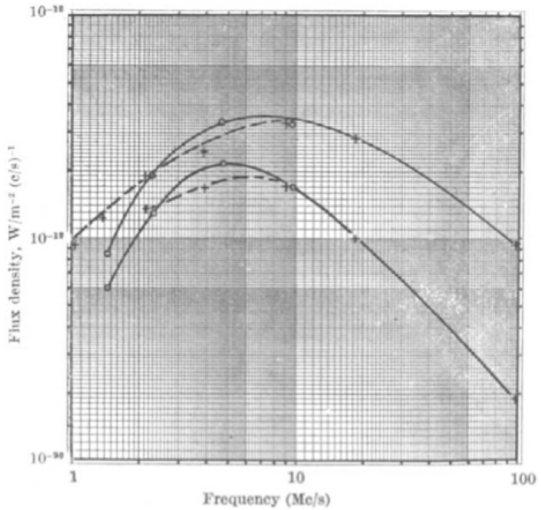

Fig. 2. Cosmic noise spectra less than 100 Mc/s. The 1956 spectra are shown dotted. Points above 10 Mc/s from ref. 2. Present observations indicated thus ○

Similar arrays of three full-wave dipoles were used at each frequency, directed to declination −42°. The bandwidth of the receivers was 4 kc/s and a combination of frequency sweeping and minimum recording was used to reduce interference from transmitting stations and atmospherics. The receivers were calibrated with noise generators.

Fig. 1 shows samples of the records at 4·8 Mc/s, 2·3 Mc/s and 1·5 Mc/s. Only records for which ionospheric modulation of the radiation appeared to be absent were used in calculating the intensities. The ionospheric critical penetration frequency, foF_2, was on a number of occasions less than 1 Mc/s and many records were obtained which reproduced the galactic sidereal profile.

Fig. 2 shows the spectra of the maximum and minimum galactic intensities, observed near 1900 R.A. and 0400 R.A., respectively. The spectrum of the maximum at frequencies less than 10 Mc/s should be interpreted with caution since high-resolution studies at 4·8 Mc/s (to be reported elsewhere) have shown much fine detail near the plane of the Milky Way. This spectrum represents an average over bright and dark regions. The spectrum of the minimum, on the other hand, is not affected significantly by spatial averaging.

Also shown in Fig. 2 are the corresponding spectra obtained in 1956[1]. It may be seen that the present spectra agree well between 2 Mc/s and 10 Mc/s. However, it now appears that the intensity decreases more below 2 Mc/s than was previously thought. In particular the 900 kc/s intensity was obtained in 1956 under rather unusual ionospheric conditions and may have to be revised in a downward direction when further results become available. It should be noted that the spectral maximum occurs at a higher frequency near the plane of the galaxy than at high galactic latitudes. In addition, at frequencies less than the spectral maximum, the intensity varies very nearly as the square of the frequency. Both of these effects may be explained in terms of absorption of the radiation in interstellar ionized gas. Their theoretical implications are discussed elsewhere[3].

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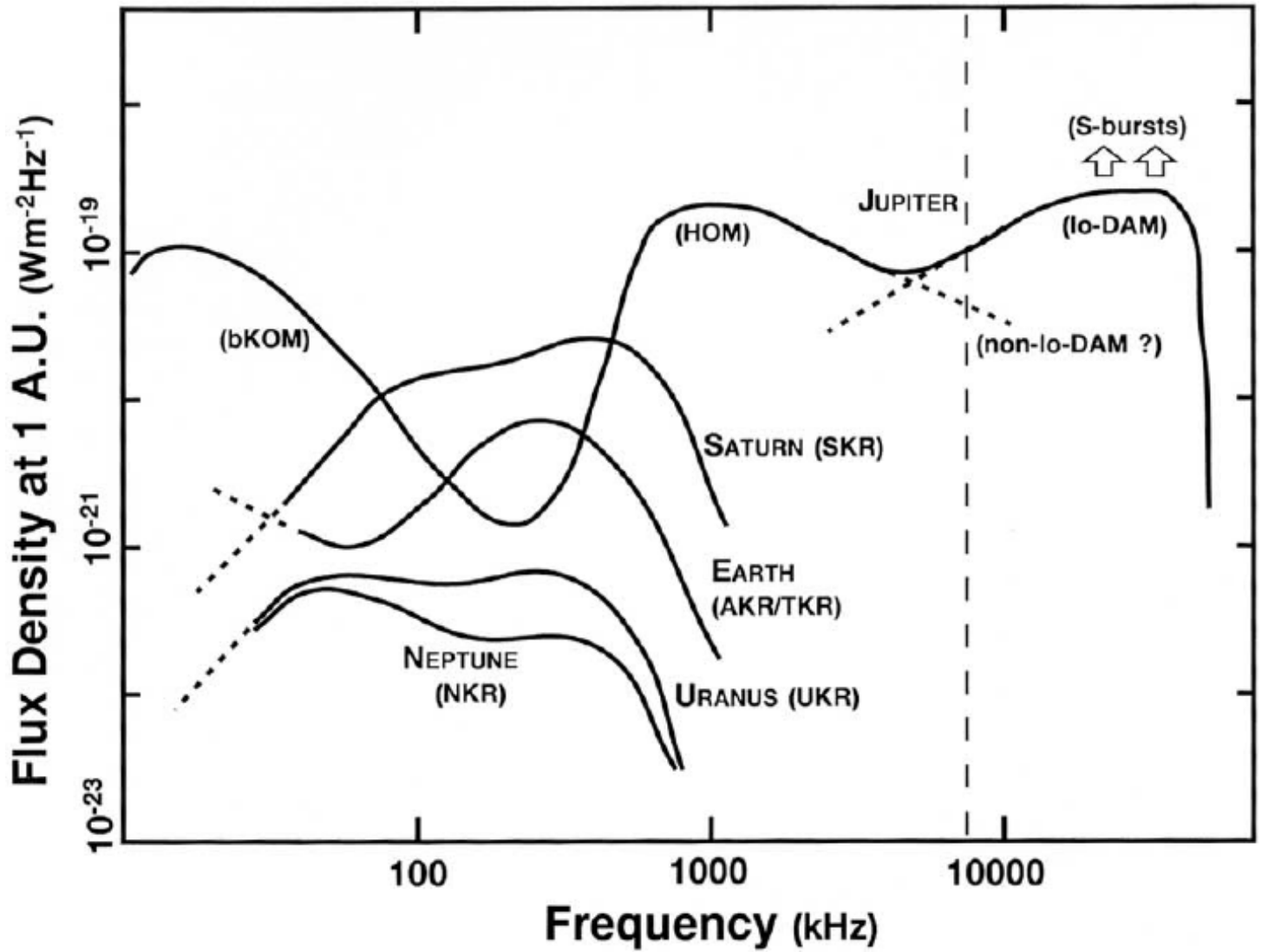
[1] Ellis, G. R. A., *J. Geophys. Res.*, **62**, 229 (1957).
[2] Higgins, C. S., and Shain, C. A., *Austral. J. Phys.*, **7**, 460 (1954).
[3] Hoyle, F., and Ellis, G. R. A., *Austral. J. Phys.* (in the press).

The Very Low Frequency Sky

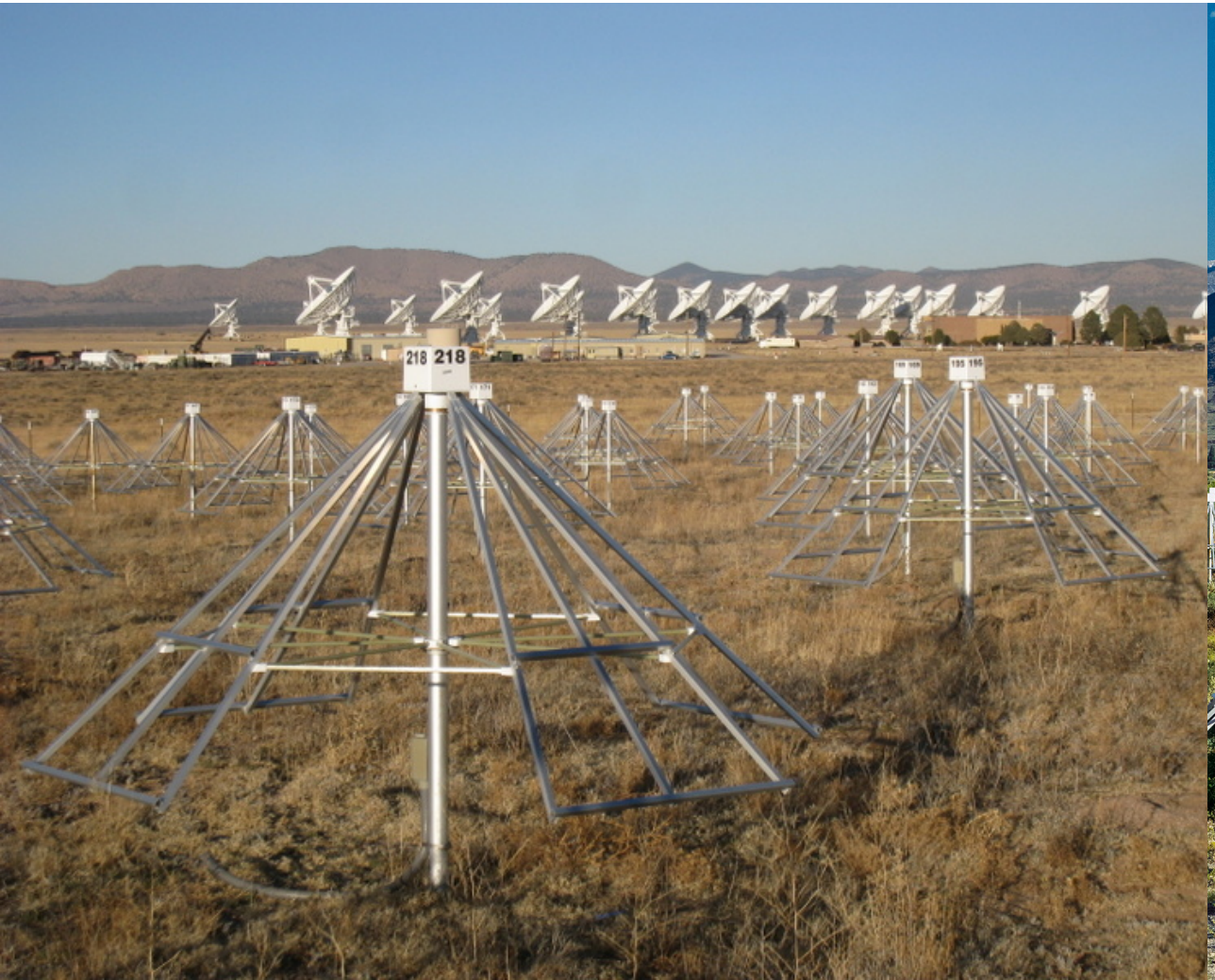


Probing Diffuse Ionized Gas

- Free-free absorption & emission (low frequency)
- Pulsar dispersion measure
- Rotation measure of polarized sources (including Galactic synch)
- Recombination radiation (primarily Halpha)
- Collisionally excited lines [NII], [SII], weak lines of [OI], [NI], [OIII]
- resonance lines in absorption (UV)
- Radio Recombination Lines (Rydberg atoms)
- 2 Photon continuum (near UV)

LOFAR (Netherlands)

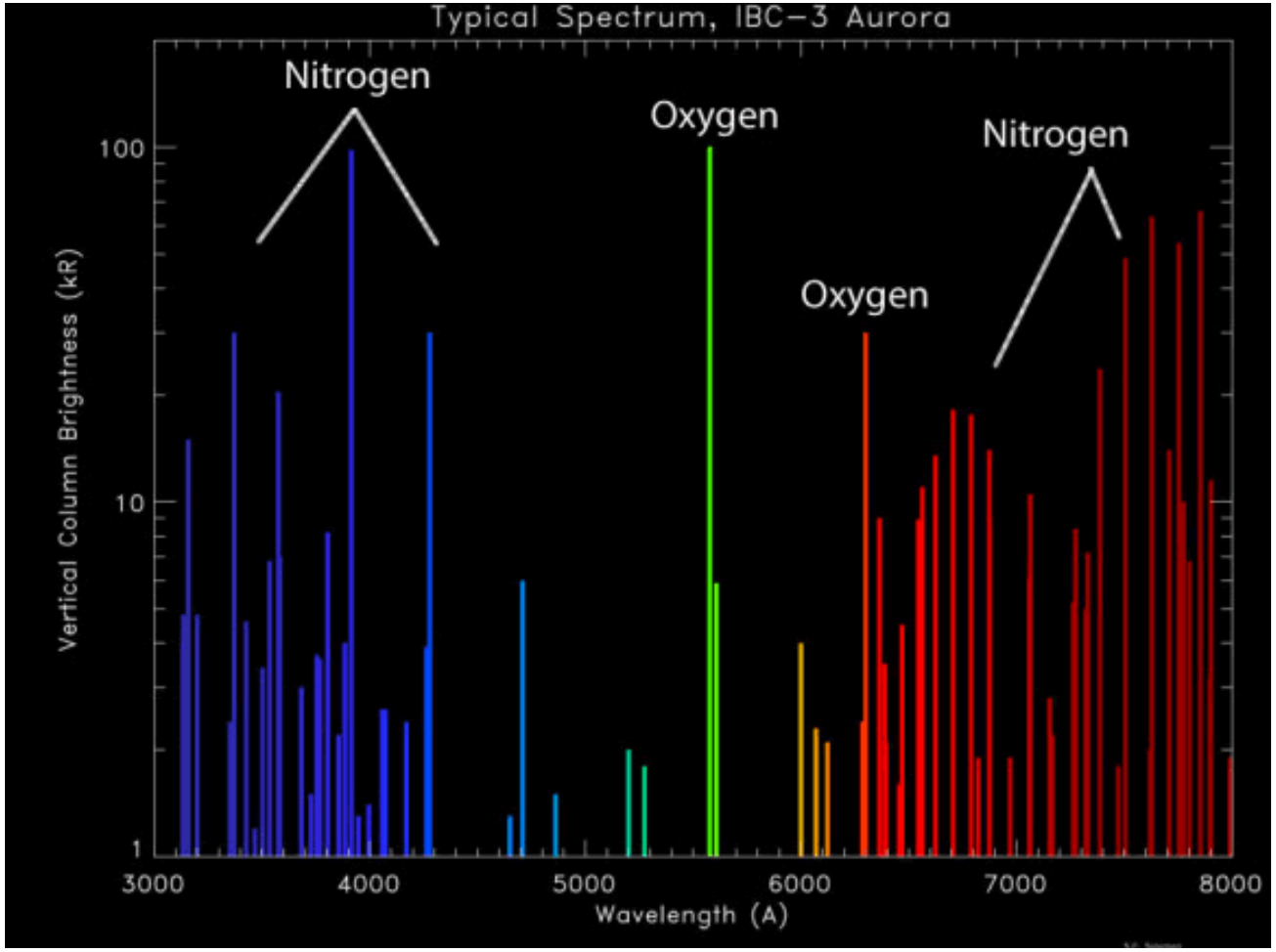
Long Wavelength Array (LWA), California



MWA, Australia

Night sky

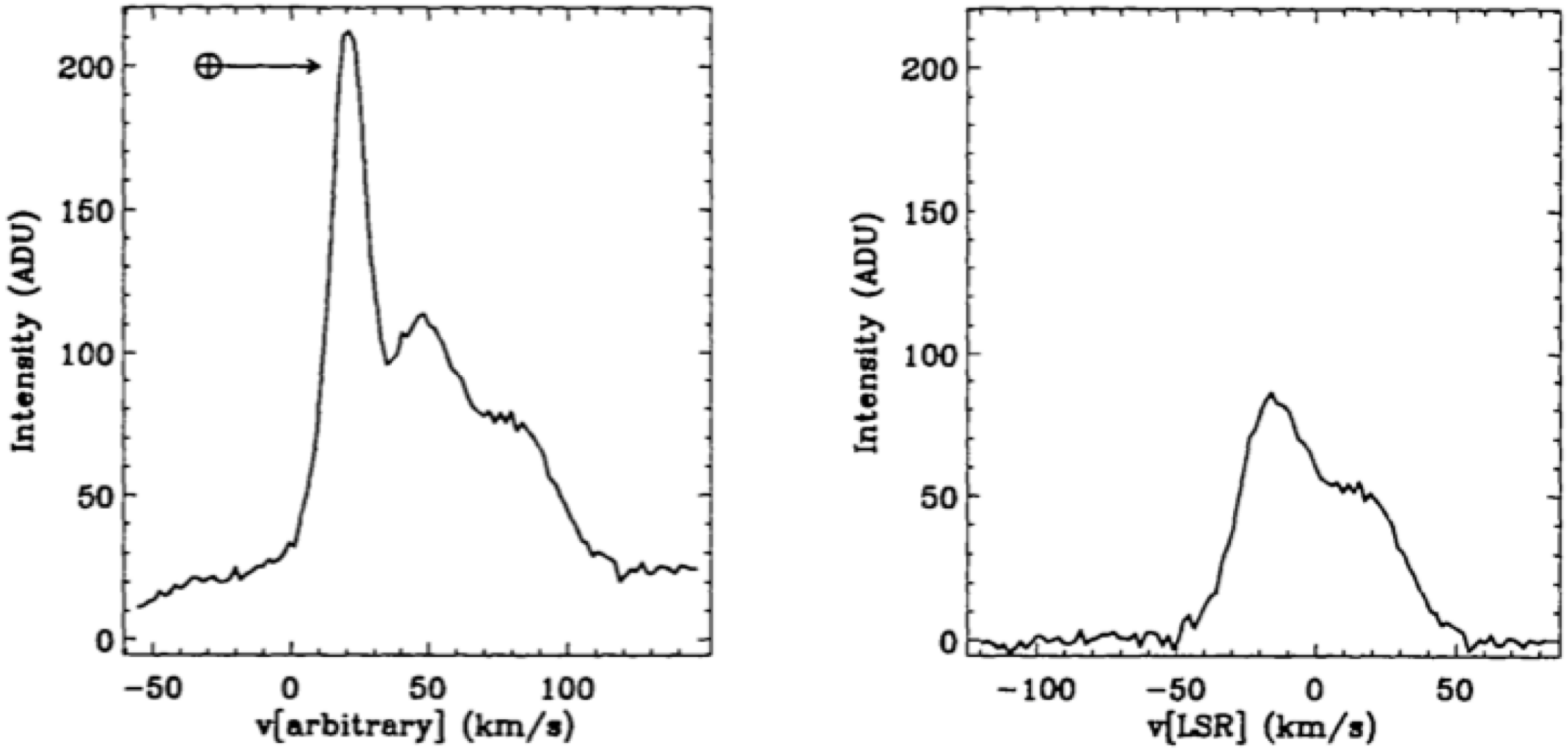
The spectrum of the Aurora



WIM lines are faint, compete with auroral emission

WHAM Halpha data (Left): Includes geocoronal Halpha emission (marked with symbol for Earth. (Right): geocoronal emission removed

Reynolds, R. J. ASP Conf # 168, p149 (1999)



Rayleigh: Unit for intensity. Defined to be 10^6 phot/cm^2/second/steradian

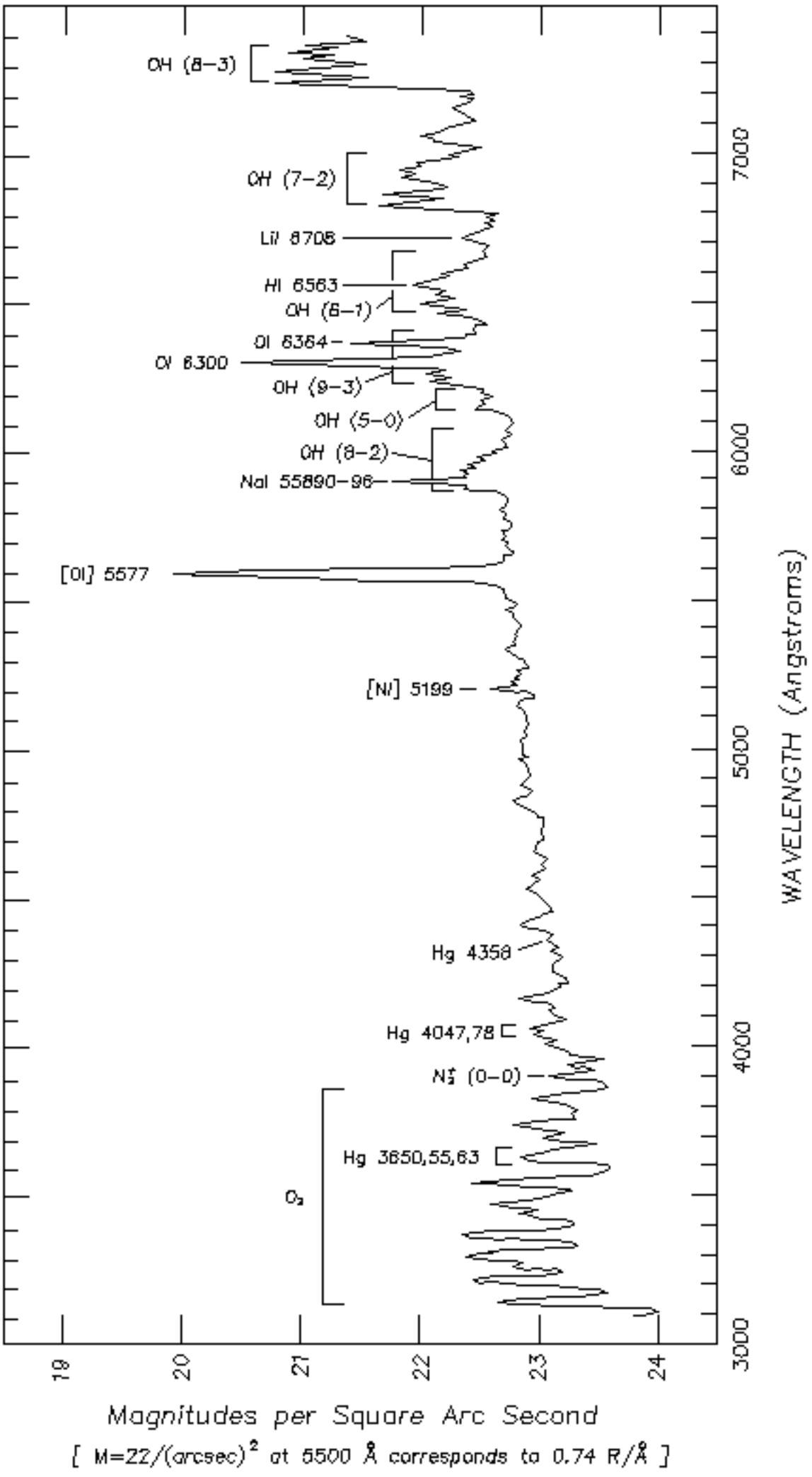
Mauna Kea night sky

Night sky brightness in U increases by a factor of 5 at quarter moon and 65 at full moon. Corresponding values in V are 1.3 at quarter and 5 at full moon. These rough estimates are of are, of course, for clear (cirrus-free) nights.

Average sky brightness at zenith during dark time is given in the table below.

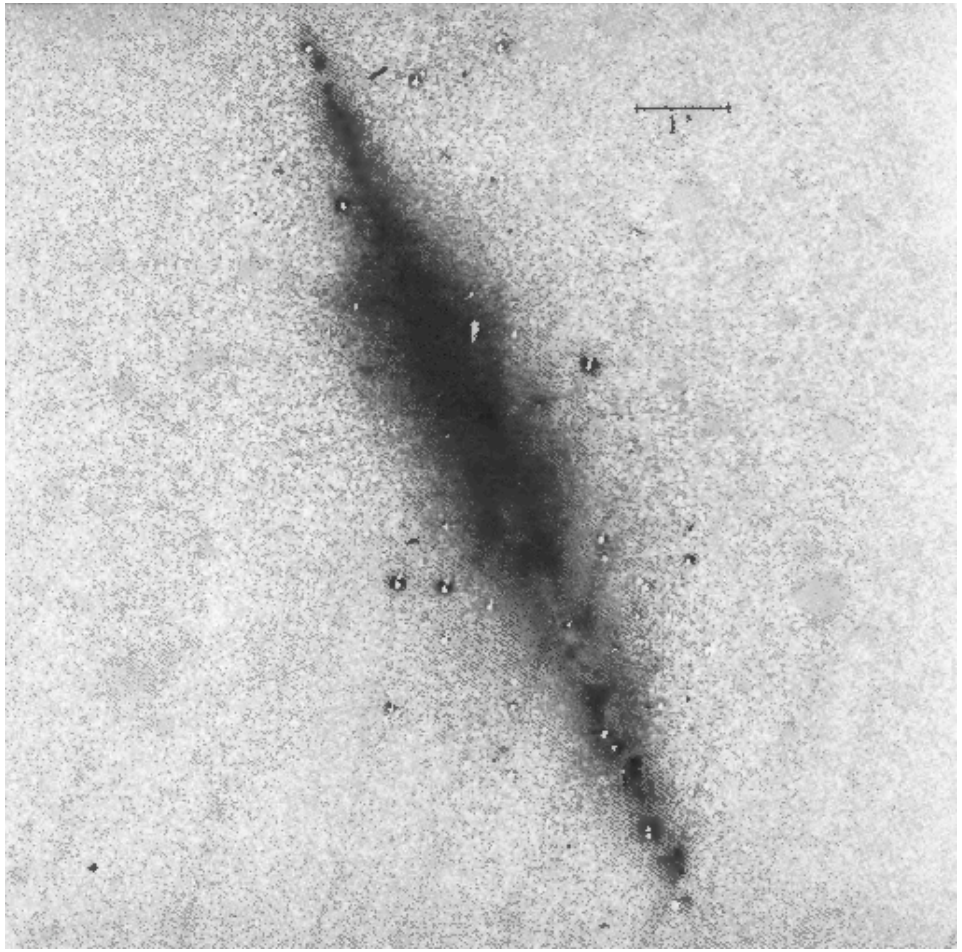
Color	Equivalent (lambda, um)	Brightness [mag/(")^2]	Flux [phot./cm^2/s/ microns/(")^2]
U	0.36	21.6	1.74x10e-2
B	0.44	22.3	1.76x10e-2
V	0.55	21.1	3.62x10e-2
R	0.64	20.3	5.50x10e-2
I	0.79	19.2	1.02x10e-1
J	1.23	14.8	2.49
H	1.66	13.4	4.20
K	2.22	12.6	3.98

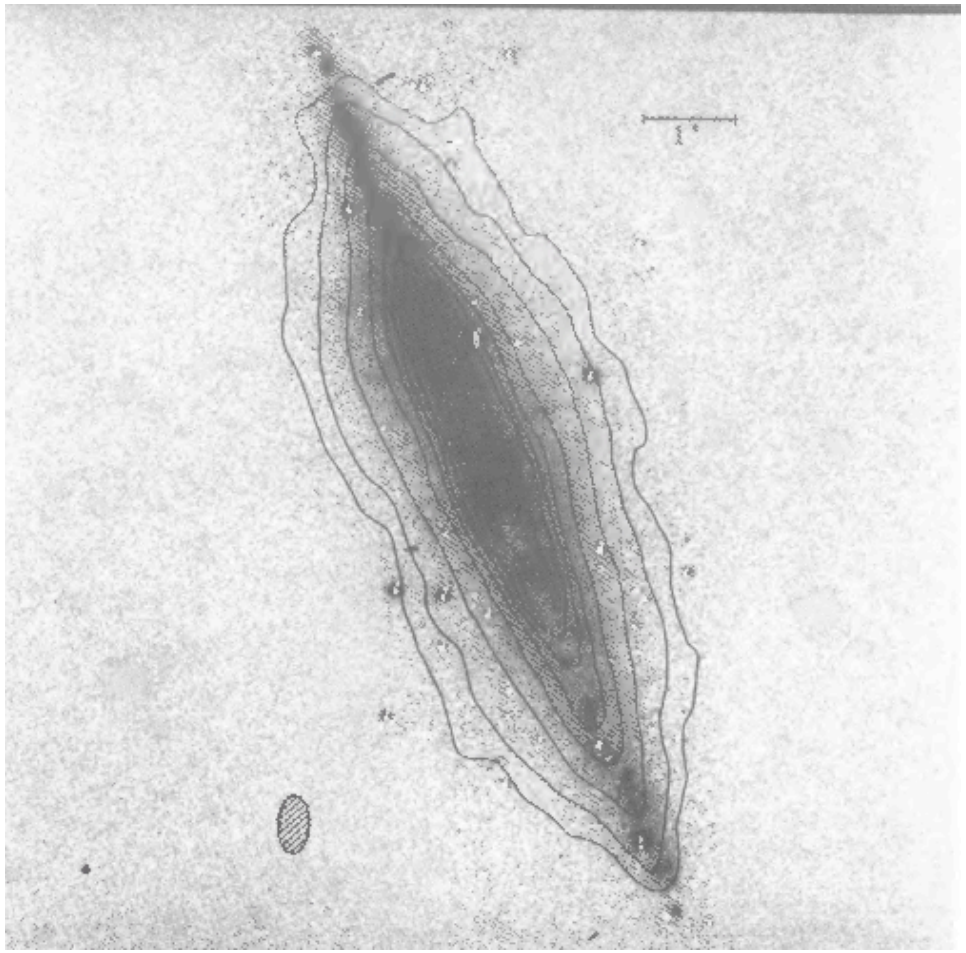
http://www.cfht.hawaii.edu/Instruments/ObservatoryManual/CFHT_ObservatoryManual_%28Sec_2%29.html


OH (8–3)
OH (7–2)
LiI 6708
HI 6563
OH (6–1)
OI 6364
OI 6300
OH (9–3)
OH (5–0)
OH (8–2)
NaI 55890–96
[OI] 5577
[NI] 5199
Hg 4358
Hg 4047,78
N$_2^+$ (0–0)
Hg 3650,55,63
O$_2$
7000
6000
5000
4000
3000
WAVELENGTH (Angstroms)
18
20
21
22
23
24
Magnitudes per Square Arc Second
[M=22/(arcsec)^2 at 5500 Å corresponds to 0.74 R/Å]

WIM in other galaxies

WIM in other galaxies





Richard Rand (PhD thesis, Caltech)

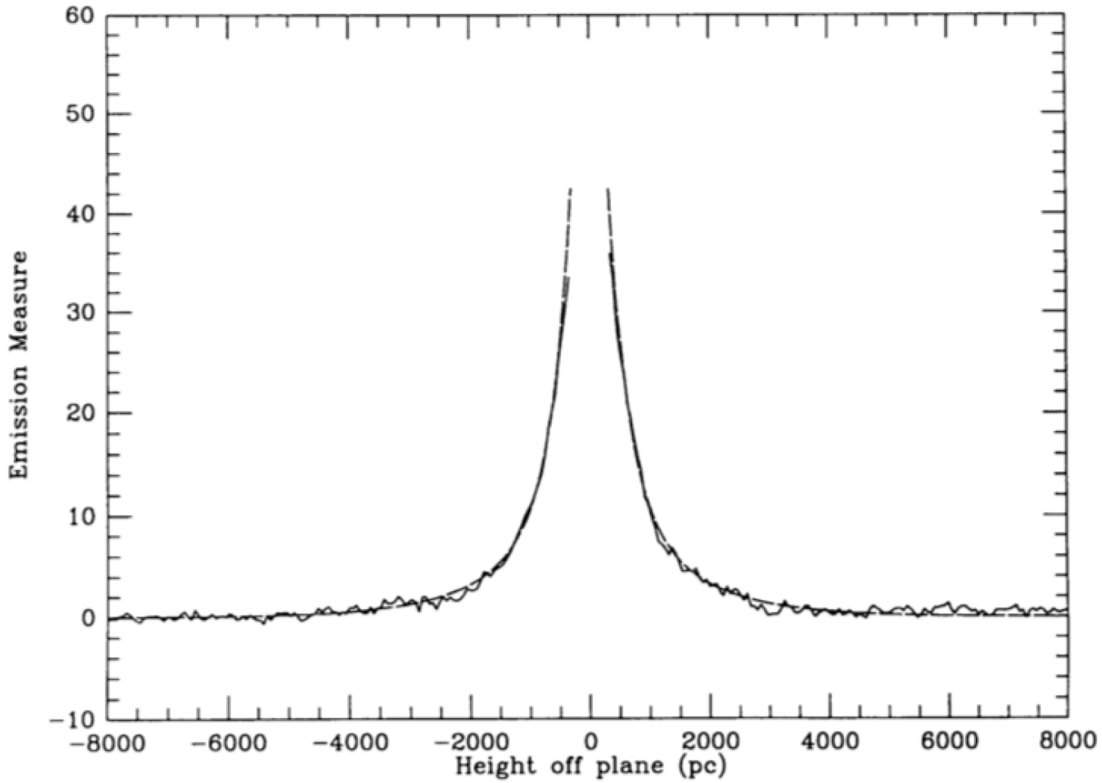


FIG. 2*a*

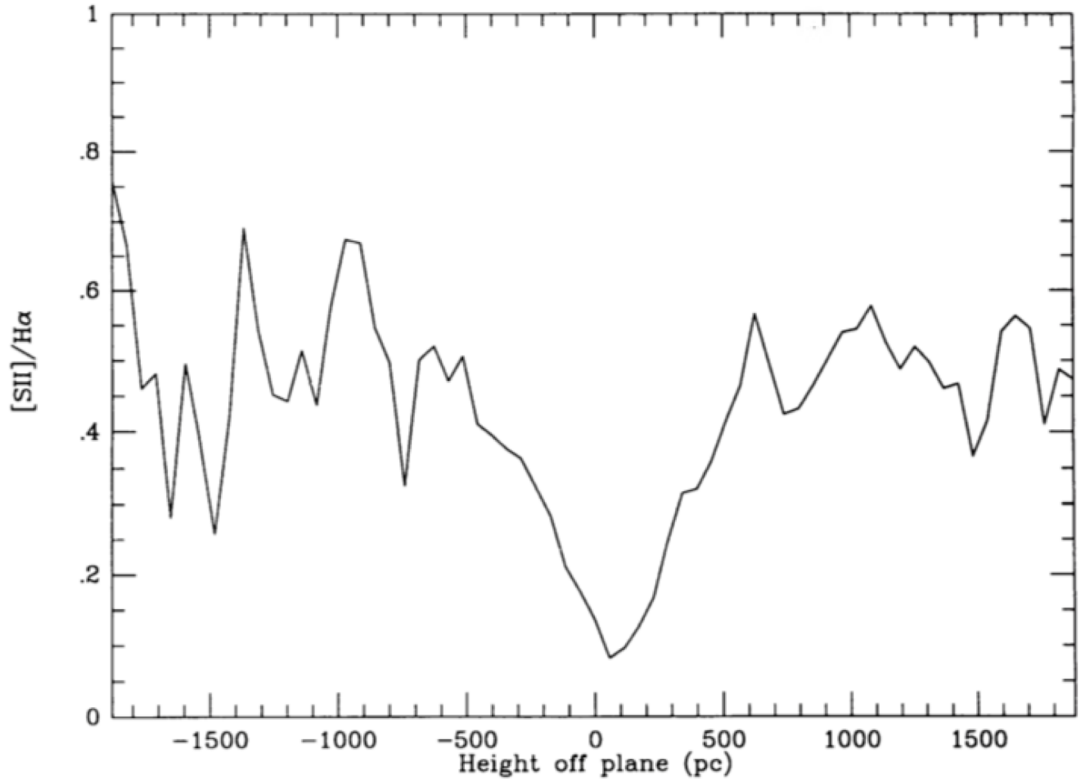


FIG. 2*b*

FIG. 2.—(*a*) The vertical distribution of emission measure averaged over the range 2–5 kpc north of the nucleus, for $z > 300$ pc, and our fit to the distribution (*dashed* line). (*b*) The vertical distribution of the [S II]/Hα ratio through a bright H II region in the plane at about 500 pc SW of the nucleus. Absolute calibration of the [S II] data has *not* been done. The value of the ratio at the midplane has been arbitrarily set to 0.1, the typical value for Galactic H II regions.