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Recent Spectra of the F-Type Hypergiant OH/IR Maser IRC+10420

ABSTRACT

IRC+10420 has the spectrum of a very luminous F supergiant (F8Ia+) plus a very large IR excess from circumstellar dust (Humphreys et al. 1973). It is also one of the warmest known OH/IR source (Giguere et al. 1976). A mass loss rate of $3x10^{-4}$ $M_\odot$/yr has been estiated from its CO emission (Knapp and Morris 1985). Recent OH observations show that the 1665 MHz feature is growing (Lewis et al. 1986). It has also brightened by about a magnitude from 1930 to 1970 (Gottlieb and Liller 1978). This is what we would expect if the dust shell were dissipating. The interpretation of IRC+10420 will depend on its luminosity and therefore its distance.

DISTANCE AND LUMINOSITY

With a B-V of $\sim$2.7 mag IRC+10420 is very highly reddened, but what component is interstellar and circumstellar? If all of the B-V color excess is interstellar then $A_v \gtrsim 6.5$ mag. Polarization measurements by Craine et al. (1976) allow us to set additional limits: if all of K band polarization (1.4%) is IS -- minimum case! $\tau_K \sim 0.55 \Rightarrow A_v \gtrsim 6$ mag. Subtracting this IS component at V yields an intrinsic V band polarization of at least 3% and more likely 6%. Thus, the minimum IS reddening is 6 mag from the polarization; therefore, we will assume the entire color excess is due to IS dust and $A_v \gtrsim 6$ mag!

Photometric Distance - From IS extinction of other stars toward $\ell=47^\circ$ ($\pm 2^\circ$) the reddening increases greatly up to 4 mag (A_v) at distances of 3 to 4 kpc. Therefore: IRC+10420 $\geq$ 4 kpc from the Sun.

Kinematic Distance - IRC+10420 ($\ell+47^\circ$, b = -2.5°) has a large positive velocity of +75 km/sec (LSR). The maximum observed HI velocity at this longitude and latitude is also +75 km/sec. IRC+10420 is probably associated with this HI feature. Assuming that the maximum velocity occurs at the tangent point gives: 5.8 kpc kinematic distance (R_o = 8.5 kpc). Then integrating the energy distribution from .5μ to 25μ yields M_{Bol} = -9.2 to -10.0 mag for a distance range of 4-6 kpc.

THE SPECTRUM

Because of its very large reddening, IRC+10420 is very faint at visual wavelengths and for that reason a high resolution spectrum has been lacking. We obtained an echellette spectrum covering 3900-10250Å with a resolution between 1 and 2Å in the blue-visual with the cassegrain spectrograph and cross-disperser on the 3.5-m telescope at Calar Alto plus an Hα spectrum at a resolution of .5Å with the Coude spectrograph on the 2.2-meter telescope also at Calar Alto.

The absorption line spectrum is that of a very high luminosity F supergiant. The OI blend at 7774Å a very positive luminosity indicator, is very strong in IRC+10420. The most interesting features are the dual peaked Hα profile and strong emission in the CaII 'infrared' triplet near 8500Å and the [CaII] lines near 7300Å.

Hα profile: The absorption dip has the same velocity as the asorption lines in the F supergiant spectrum and therefore arises in the stellar photosphere. The two emission components are symmetrically displaced at -53 km/s and +56 km/s. The Hα emission is most likely produced in a disk. The high intrinsic polarization also suggests a strongly asymmetric geometry for the scattering, - a disk geometry is required for polarization as large as 6% (Jones and Gehrz 1990). Diamond, Norris and Booth (1983) also suggested that although the OH emission is clumpy, it is probably produced in an annular (disk-like) region.

The lack of any significant circumstellar reddening at visual wavelengths means that we are viewing the F supergiant photosphere directly, and the disk where most of the dust probably exists is not blocking the line of sight to the star.

The very broad wings in the Hα profile might be produced in a more symmetrical mass outflow. They are very similar to the Hα profiles observed in the B[e] supergiants (Zickgraf et al. 1985, 1986) and were attributed to incoherent electron scattering in the B[e] stars.

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