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LETTERS

IRAS 01005+7910: a High Galactic Latitude Post-AGB Star

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Abstract IRAS 01005+7910 is a cold IRAS source. We present its optical identification, photometric and spectroscopic observation results. Its optical counterpart is classified as a B2Ie star with V magnitude 10.85. Its H_α line shows the P Cygni profile. According to its location in the Galaxy ($b = 16.6$), we consider it to be a post-AGB star or a proto-planetary nebula.

Key words: stars: post-AGB — infrared: stars — stars: evolution

1 INTRODUCTION

Since Bidelman (1951) drew attention to the existence of peculiar F-type supergiants at high galactic latitudes, interest has grown for these sources. IRAS data show that they have considerably large infrared excesses due to circumstellar dust, which leads to the suggestion that these objects may be in a transition stage from the Asymptotic Giant Branch (AGB) to the Planetary Nebula (PN) phase. During the transition, the post-AGB or proto-planetary nebula phase, the AGB dust shell moves away from the central star, the envelope changes from being optically thick to being optically thin, and the spectra change from later type to early type. The transition between AGB and PN is believed to be very short. So to find early type post-AGB or hot post-AGB is very important for the study of stellar evolution in this transitional phase.

In our systematic search of proto-planetary nebula based on the IRAS data (Hu et al. 1993, 1994), we found such a object, IRAS 01005+7910, located at galactic latitude of $b = 16.6$, whose spectrum was classified as B2 supergiant. We considered it to be one of the most interesting post-AGB stars. Recently, Hrivnak et al. (2000) found that the source shows carbon-rich features in infrared. In this paper we present the results of optical identification, photometric and spectroscopic observations and a discussion on its nature.

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2 OPTICAL IDENTIFICATION AND OBSERVATIONS

2.1 Optical Identification

IRAS 01005+7910 was optically identified by using Digitized Sky Survey (DSS). The finding chart, showing a bright object within the IRAS position error box, is displayed in Fig. 1. In Table 1 we list its optical position, derived from USNO A2.0 and its IRAS position. As we will show later, the H_α line of this optical source shows a P Cygni profile and its $E(B-V)(=0.39)$, is large for an object at $b = 16.6$, which confirms our identification.

2.2 Photometric Observation

The optical photometric observation was carried out in October 1990, using a CCD detector on the 1.0 meter Kaptyen telescope at La Palma. The Johnson $BVRI$ system and standard stars listed by Landort (1983) were used to operate brightness calibration. The results of the BVRI photometry and its IRAS flux are listed in Table 2.

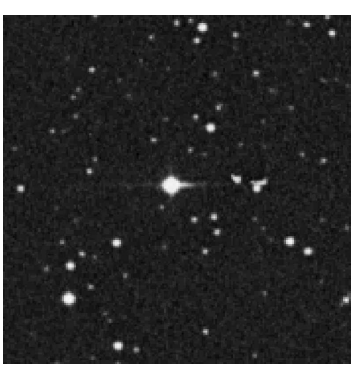

Fig. 1 Finding chart ($5' \times 5'$) for IRAS 01005+7910, north is up.

Table 1 Optical and IRAS Positions of IRAS 01005+7910

	R. A. (2000.0)	Dec. (2000.0)
Optical	01 04 45.48	+79 26 46.3
IRAS	01 04 44.5	+79 26 43

Table 2 BVRI Magnitude and IRAS Flux of IRAS 01005+7910

Magnitude	IRAS Flux
$B = 11.08$	3.90 Jy (12 micron)
$V = 10.85$	24.23 Jy (25 micron)
$R = 10.68$	10.07 Jy (60 micron)
$I = 10.50$	2.42 Jy (100 micron)

2.3 Spectroscopic Observations

The low resolution optical spectra were taken in November 1990 using the 2.5 m Issac Newton Telescope (INT) at La Palma and the FOS with a RCA CCD detector with a resolution of 10.7Å/pixel. In January 2000, about 10 years later, we took another low resolution spectrum using the 2.16 m telescope at Xinglong Station, Beijing Astronomical Observatory, and an OMR spectrograph with a TEK1024 CCD. We cannot find any difference between the two spectra taken within an interval of 10 years. A follow-up intermediate resolution spectra were obtained immediately using IDS attached on the INT and the same OMR spectroscopy but with a higher resolution grating. In both intermediate spectra the H_α line shows the P Cygni profile, but we could not find any evidence of variability either. Figure 2 shows the intermediate spectra covering from 3600Å to 6900Å, taken in 2000; the inserted panel in Fig. 2c is an enlarged portion near the H_α emission.

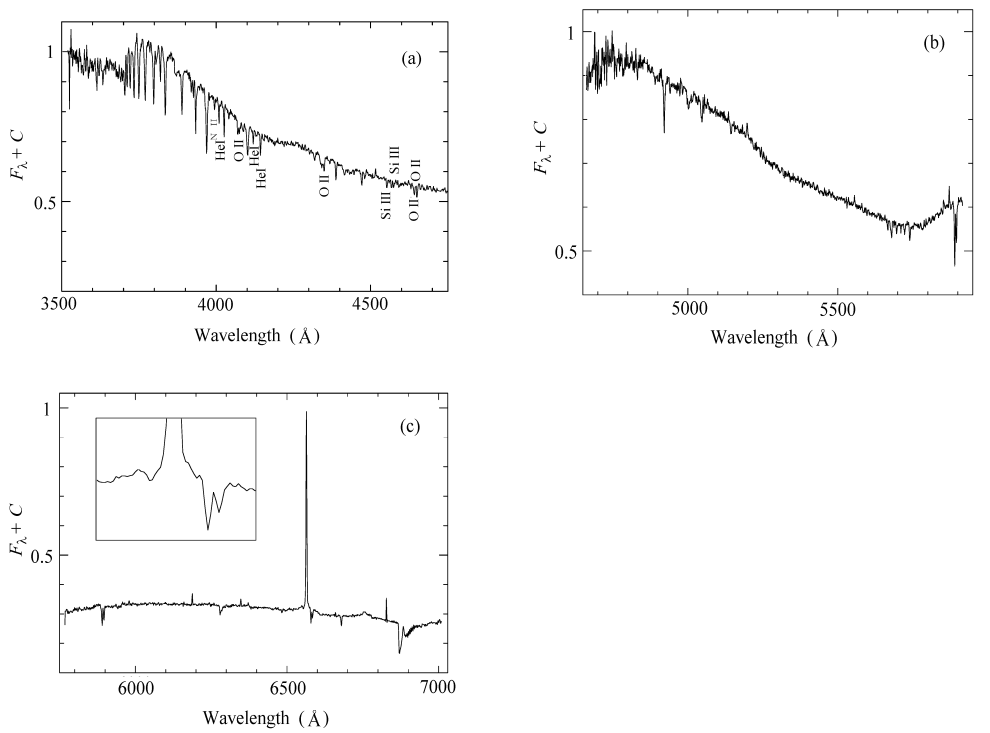

Fig. 2 Optical spectrum of IRAS 01005+7910, (a), (b) and (c) are the spectrum in the blue, yellow and red parts, respectively. An enlarged curve in the top of (c) shows the P-Cygni structure of the H_α line.

3 DISCUSSION

3.1 The Spectral Type

The two-dimensional spectral type was classified based on the blue part of intermediate resolution spectrum taken in 2000. We followed the criteria described in Jasheck and Jacheck (1987). Because the spectrum shows strong HeI lines but with no HeII features, its spectral type should be later than O-type. According to the existence of OII, SiIII and SiIV lines, it ought to be earlier than, or equal to B2. However, the ratio of SiIII λ4552/SiIV λ4089 is quite small, and we can confirm that it is a B2 type star. The luminosity of this object is determined by the ratios of NII λ3995/HeI λ4009, and HeI λ4121/HeI λ4144, from which we conclude that it is a supergiant. The narrow profile of the Balmer lines are consistent with this luminosity classification.

3.2 Nature of the Object

If this object is a normal B2I star, we have $(B-V)_0 = -0.16$ and $M_V = -6.4$. The observed color is $B-V = 0.23$. So we can derive the reddening $E(B-V) = 0.39$ and interstellar absorption $A_v = 1.20$, and the distance module $m - M = 16.05$ and distance $d = 16.2$ kpc. For its galactic latitude of 16.6, the object should be located at about 4.6 kpc above the galactic plan. As is well known, the scale height of supergiants in the Galaxy is about 60 pc (Gilurore & Zeiliu 1999), so it does not fit in with being a normal B-type supergiant and accordingly we confirm that the object is a post AGB or proto-planetary nebula.

Recently, IRAS 01005+7910 was observed by ISO (Hrivnak et al. 2000). According to the infrared spectra, it is considered to be a carbon-rich proto-planetary nebula.

3.3 Mass-Loss from IRAS 01005+7910

The H_α line of IRAS 01005+7910 shows a P Cygni profile with a velocity of 450 km s^{-1}. This means that the mass-loss process in this object is on-going. It is consistent with the result given by Hrivnak et al. (2000).

4 CONCLUSIONS

Finally we conclude that

1. The optical counterpart of IRAS 01005+7910 is a B2Ie star;
2. It is a post-AGB star or a proto-planetary nebula;
3. The mass-loss process of this object is on-going.

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