Mem. S.A.It. Suppl. Vol. 14, 127

Memorie della
Supplementi

IRAS F18187+6304: a puzzling emission line star

C. Rossi[1], S. Gaudenzi[1], A. Frasca[2], L. Spezzi[3], R. Nesci[1], S. Sclavi[1], A. Magazzù[4], A. Mikaelian[5], and K. Gigoyan[5]

[1] Università La Sapienza Roma –Pza A Moro 5,I-00162 Roma, Italy
e-mail: corinne.rossi@uniroma1.it
[2] INAF - Osservatorio Astrofisico di Catania via S. Sofia 78, I-95123 Catania, Italy
[3] Space Science Department, ESA-ESTEC, The Netherlands
[4] Fundación Galileo Galilei-INAF, P.O. Box 565, 38700 Santa Cruz de La Palma, Spain
[5] Byurakan Astrophysical Observatory, Byurakan 378433, Armenia

Abstract.
We observed in the optical range the strong infrared source IRAS F18187+6304 in the context of a program aimed to clarify the nature of the stellar objects of the Byurakan Infrared Source catalogue. The optical spectrum is characterized by continuum and absorption lines typical of early K-type giants plus a few permitted and forbidden emission lines. The sparse optical photometry did not put in evidence strong variations during the last 50 years. Our repeated observations indicate a substantial stability of the spectra and a monotonic increase of the luminosity in the BVR bands of about 0.4 magnitudes between Summer 2007 and Fall 2008. From a high resolution spectrum we measured a heliocentric radial velocity of -25 km/s and discovered a complex NaI-D structure resembling that of some T Tauri stars; the infrared CaII triplet is in absorption. A strong IR excess in the IRAS bands indicates a substantial quantity of circumstellar dust and gas. IRAS F18187+6304 is an isolated star at quite high galactic latitude, far from any star forming region. All these characteristics make this object an intriguing case of difficult interpretation. The preliminary results are discussed in the framework of the available synthetic energy distribution and accretion models.

Key words. Stars: emission-line; Stars: variables; Stars: individual, IRAS F18187+6304

1. Introduction

The optical counterpart of the IRAS-PSC infrared source F18187+6304 was recognized as a late-type star by Gigoyan & Mickaelian (1999) in a survey of stars at high galactic latitude detected on the objective prism plates of the First Byurakan Survey. This is an isolated star, far from any star forming region and is not associated with any interstellar nebulosity. On the other hand the optical spectrum resembles that of pre-main sequence stars and a strong infrared excess indicates the presence of a large circumstellar envelope. It challenges therefore the canonical scenario that stars are born in groups, rather than as isolated objects.

2. Observations

We made a photometric and spectroscopic monitoring of the star starting in September

Send offprint requests to: C. Rossi

2007 with the 152cm and 182cm telescopes of the Loiano and Asiago Observatories. During several runs we obtained photometric data with BFOSC and AFOSC in the B and R Johnson filters and in some cases V and I. In the same dates we also collected spectra with the same instruments using several grisms for different spectral ranges and resolutions. We also obtained some flux calibrated spectra using spectrophotometric standards. A high-resolution spectrum in the red spectral range was obtained at TNG with the SARG spectrograph at the lowest resolution (R 25000). The K5III star 70 UMa was also taken with the same setup as a radial velocity reference.

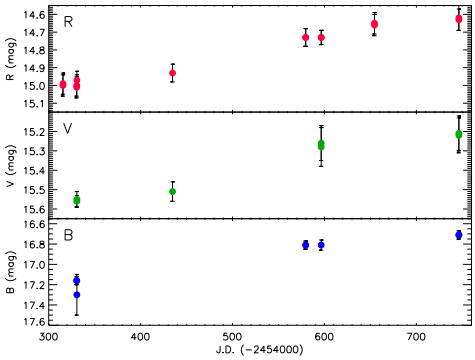

Fig. 1. *BVR* CCD photometry obtained from 2007 to 2008.

3. Results

3.1. Optical photometry

To build an historical light curve of this star we performed aperture photometry on all the DSS images available on line, defining a comparison sequence based on the GSC2.3 catalogue. A further red magnitude at intermediate epoch was derived from the Digitized First Byurakan Survey (Mickaelian et al. (2007)), using the same reference stars. The same photometric sequence was also used to calibrate our CCD images; the CCD light-curves are reported in Fig. 1 and show a variability of about 0.5 mag, while the B-V color index remained constant at about 1.62 .The old photographic data showed a limited variability (0.5 mag) at an average flux level comparable to the recent one.

3.2. Low resolution spectra

The low-resolutions flux-calibrated spectra allowed us to perform a spectral classification of the target by using a modified version of ROTFIT, a code for spectral type determination developed by Frasca et al. (2003) under the IDL environment. The best fit is obtained with a K2 III template; the average extinction, effective temperature and gravity derived are A(V)=1.10, T_{eff} 4350 K and log(g) = 2.5. The emission lines (NaD, Hα, N[II], S[II]) are indicative of a thick circumstellar envelope (see Fig. 2).

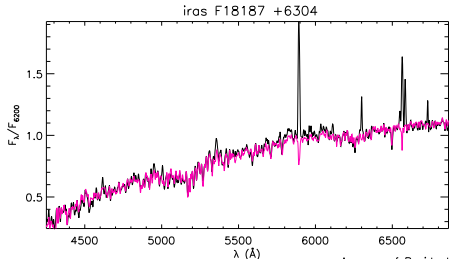

Fig. 2. Observed BFOSC spectrum of IRAS F18187+6304 (thick line) with the best K2III templatesuperimosed (thin line). The strongest emission is the sodium doublet. Emission in the Hα, [NII] λ6548 and λ6584, [OI] λ6300, and [SII] λ6734 lines is also apparent.

3.3. Spectral energy distribution

Using the JHK magnitudes from the 2MASS archive we placed the star in a color color infrared diagram, correcting the magnitudes for the extinction according to Bessel & Brett (1988): we obtained A(K)=0.12 and the color excess E(J-H)=0.130, E(H-K)=0.067. The dereddened colors J-H=0.75, H-K=0.68 place this star in the region occupied by young stars, supporting the spectroscopic evidence. Concerning the far infrared (IRAS) colors we corrected the IRAS fluxes following the pre-

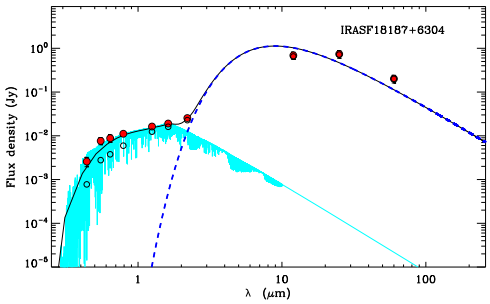

Fig. 3. Spectral energy distribution of IRAS F18187+6304. The NextGen spectrum with the same temperature as the star (T_{eff}=4400 K) is overplotted, representing the stellar photospheric emission. The dashed line is the result of the fit to the observed IR flux-excess assuming black-body (T_{eff}=570 K) emission from the disk. The continuous line is the sum of the star and disk emissions.

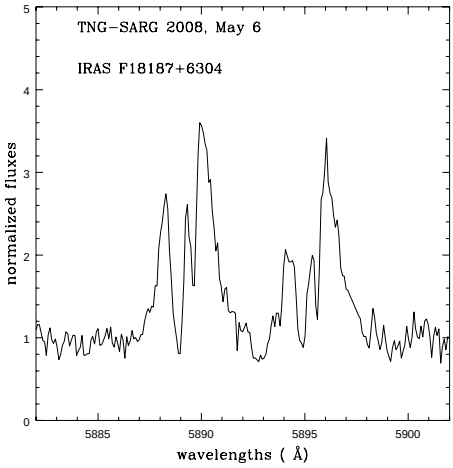

Fig. 4. SARG spectrum of IRAS F18187+6304 in the NaI D_2 region.

scriptions given in the PSC-ES for a temperature of 500K (see below) to compute the final magnitudes; we obtained the following color indices: K-[12]=6.90, [12]-[25]=1.50, [25]-[60]=0.50, again in the region of young objects. The K-[12] color index of F18187+6304 is very red. We remember that K-[12] is a good indicator for circumstellar envelopes because the K flux originates from the star while a large [12] indicates the presence of a cool circumstellar component. In our case the large K-[12] imply a thick shell with a characteristic temperature of few hundred degrees.

3.4. Model fitting

We have fitted a "synthetic" SED to the observed one by combining a NextGen low-resolution synthetic spectrum (Hauschildt et al. (1999)) with a blackbody simulating the infrared excess. The NextGen parameters used to reproduce the stellar photosphere were : T_{eff}=4400 K, log(g)=2.5, and solar metallicity. The strong IR excess, already visible in the K band, has been reasonably well fitted by an isothermal disk with T_{eff}=570 K and a radius of about 286 $R_{\odot}$ (see Fig. 3).

4. Conclusions

The star revealed to be a complex object. A preliminary spectral analysis pointed towards a classification as a T Tauri star, but such an interpretation is not without problems. A strong IR excess in the IRAS bands indicates a substantial quantity of circumstellar dust and gas. The optical spectrum is characterized by continuum and absorption lines typical of early K-type giants plus a few permitted and forbidden emission lines, the strongest being the NaI-D doublet. A broad H-alpha emission is the only Balmer line present; the infrared CaII triplet is in absorption.

From our high resolution spectrum taken at TNG we measured a low heliocentric radial velocity of -25 Km/s and discovered a complex NaI-D structure resembling that of some T Tauri stars(see Fig. 4).

From the PPMX catalogue (Roeser et al, 2008), the proper motion is very low, as expected for a distant object. If the star is actually a K giant it would be at a distance of some 5000 pc, while if it were a Main Sequence star would be just at 300 pc. A Pre Main Sequence star could be somewhat more distant, at about 1000 pc.

Apparently, this is an isolated star at intermediate (b=27, l=92) galactic latitude, far from any star forming region (the nearest association is Cep OB2 at a distance of 24 degrees) and is not associated with any interstellar nebulosity. It is not located on the Gould Belt. If it is a Pre Main Sequence object, its distance is similar to that of Cep OB2 (700 pc): however it is not very likely that it is a runaway star from that association due to the large relative distance (at least 300 pc) and the low velocity of the star. All these characteristics make this object an intriguing case of difficult interpretation, including the possibility that it is a Post Main Sequence binary star.

Acknowledgements. This work made use of the SIMBAD database. Our observational material was obtained with the INAF telescopes of Asiago-Ekar, Loiano and TNG.

References

Bessel, M.S., Brett, J.M., 1988 PASP, 100, 1134

Frasca, A., Alcalá, J. M., Covino, E., et al. 2003, A&A, 405, 149

Gigoyan K.S. & Mickaelian A.M. 1999, Astrophysics, 42, 37

Hauschildt, P. H., Allard, F., Ferguson, J., et al., 1999, ApJ, 525, 871

Mickaelian A.M., Nesci, R., Rossi C., et al. 2007, A&A464, 1177

Roeser S., Schildbach E., Schwan H., et al. 2008, A&A488, 401