
Gemini & HST observations of post-AGB objects

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Summary. We present the results of our Gemini GEM-NQ/Michelle observations of small sample of post-AGB objects: IRAS 22223+4327, IRAS 23304+6147, AFGL 618, U Mon and IRAS 08187-1905. High-resolution mid-IR images are compared with the HST images (when available) to investigate the final period of AGB mass loss and improve our understanding of the observed morphological bifurcation into two groups: SOLE and DUPLEX as introduced by Ueta et al. (2000, ApJ 528, 861).

Key words: circumstellar matter - stars: AGB and post-AGB - stars: individual (IRAS 08187-1905, IRAS 22223+4327, IRAS 23304+6147, AFGL 618, U Mon)

1 Introduction

Post-AGB objects are low to intermediate initial mass stars ($\sim 0.8 - 8M_{\odot}$) which have recently finished their evolution on the asymptotic giant branch (AGB) and are currently evolving towards the planetary nebulae (PN). During such a transition the star and circumstellar envelope undergo fundamental and rapid changes in structure, mass-loss mode and geometry, which reveal in various asymmetrical morphologies observed among reflection proto-planetary nebulae (e.g. [5], [1]). First attempt to classify these objects based on both optical and infrared properties [5] shows a bifurcation of morphologies into two distinct groups: SOLE and DUPLEX. The dichotomy is explained with different optical thickness of the circumstellar envelopes which is linked to the AGB progenitor masses. In current study, we present new Gemini infrared images and corresponding archival HST optical images of selected post-AGB objects and discuss their observed properties and morphological classes.

2 Gemini and HST Observations

Mid-infrared images of IRAS 22223+4327, IRAS 23304+6147, AFGL 618, U Mon and IRAS 08187-1905 were obtained under program GN-2004B-Q-89 (PI: M. Meixner)

with the Michelle imager and spectrometer mounted at the 8 m Gemini North telescope. Observations were secured in 2004-2005 with medium and broad bandpass filters: Si-2 (central wavelength: $\lambda = 8.8\mu m$), Si-3 ($\lambda = 9.7\mu m$), Si-5 ($\lambda = 11.6\mu m$), Si-6 ($\lambda = 12.5\mu m$) and Qa ($\lambda = 18.1\mu m$). Standard stars (selected from [2]) were observed twice for each filter before and after the source integration. Image reduction was performed using MIDIR routines under the Gemini IRAF package and IMCOADD task was used to combine multiple images from each night.

HRC/ACS observations of IRAS 23304+6147, IRAS 22223+4327 and AFGL 618 in broad B (F435W), V (F606W) and I (F814W) filters were found in the HST archives (obtained under programs: ID 9463, PI R. Sahai [4], ID 9430, PI S. Trammell). We used STSDAS and MultiDrizzle software packages to calibrate, reduce and combine the images.

3 Discussion

Our observations show that IRAS 23304+6147 and IRAS 22223+4327 are extended and axisymmetrical with characteristic two emission peaks well-resolved in silicate filters in mid-infrared. Such emissions are the main feature of toroidals [3] and are interpreted as limb-brightened peaks of an equatorial density enhancement (possible dust tori). The optical images from HST (shown in logarithmic scale) are coincident with the mid-infrared ones. The elongations of IRAS 23304+6147 and IRAS 22223+4327 in the optical and observed structures in the infrared classify the objects as SOLE [5].

AFGL 618 has distinctive two lobes of emission of very complex structure apparent in the HST image. In mid-infrared images we observe only the unresolved central part of this carbon-rich nebula which is invisible in the optical due to optically thick dust. Such a region is a distinguishing mark of core/ellipticals [3] and DUPLEX objects [5].

The remaining two proto-planetary nebula candidates, U Mon and IRAS 08187-1905, do not show any resolved structures in our mid-infrared images. However, IRAS 08187-1905 is noticeable extended in Si-5, Si-6 and Qa filters. HST images for these objects are not yet available. Thus, we are unable to classify these objects as either SOLE or DUPLEX.

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References

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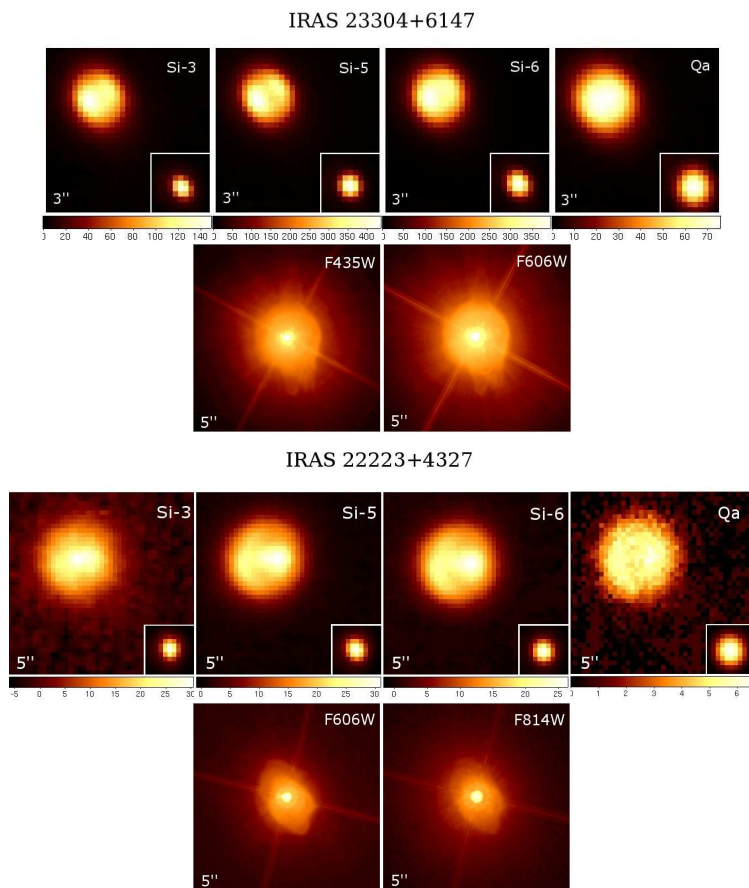


Fig. 1. Infrared and optical observations of IRAS 22223+4327 and IRAS 23304+6147 are presented. Our Gemini observations were held during 3 nights and 1 night in 2004 with comparison stars HD 216397 and HD 221588, respectively. The images in Si-3, Si-5, Si-6 and Qa filters are presented in linear scale with image sections of 3 arc seconds and comparison stars in bottom right corners. Below each set of infrared images, corresponding HST images in F606W and F814W filters are shown. These are presented in a logarithmic scale with image sections of 5 arc seconds. North is always up and east is to the left.

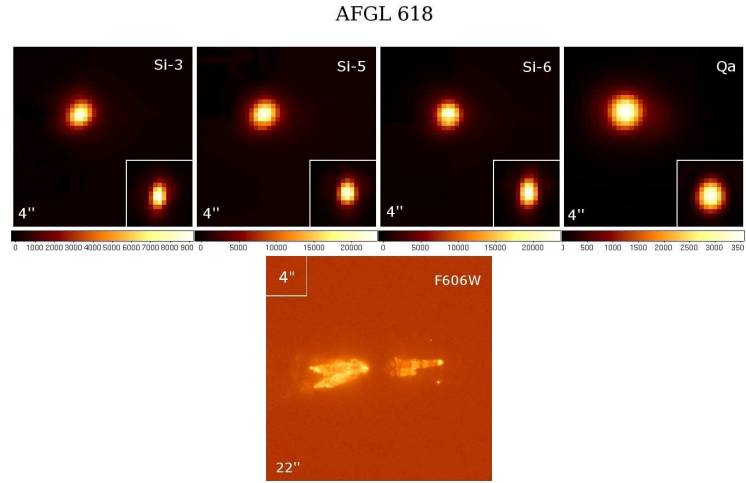


Fig. 2. Infrared (top) and optical (bottom) observations of AFGL 618. Gemini observations were held during 2 nights in 2004 in Si-3, Si-5, Si-6 and Qa filters. Images from 1 night are presented in a linear scale with a comparison star HD31398 in bottom right corners and image sections of 4 arc seconds. HST image in F606W filter and image section of 22 arc seconds is also shown with white box denoting the size of infrared images sections. North is up and east is to the left.

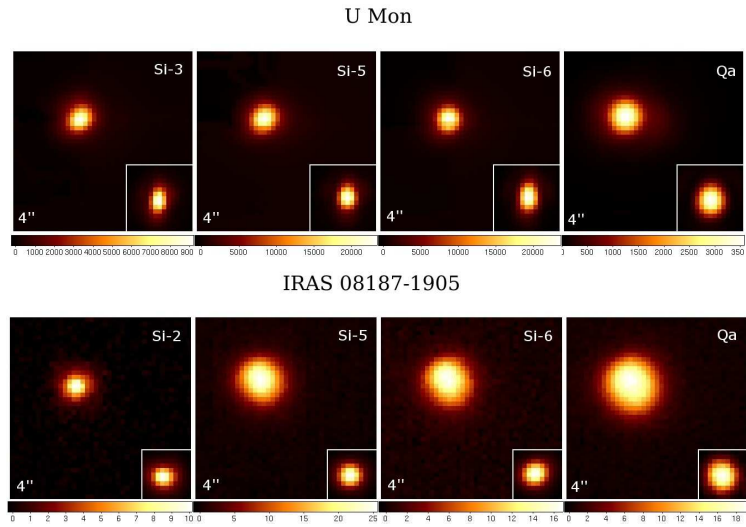


Fig. 3. Infrared observations of U Mon and IRAS 08187-1905 and their comparison stars - HD 59381 and HD73603, respectively - are presented. The images in Si-2, Si-5, Si-6 and Qa are shown in linear scale with image sections of 4 arc seconds. North is up and east is to the left. No corresponding HST images were found available.