NLTE Analysis of Central Stars of Highly Excited Planetary Nebulae

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Introduction

Very hot central stars (CSPN) of highly excited planetary nebulae (PN) display the formation of white dwarfs. At the hot phase of their evolution, they are close to the end of nuclear burning and gravitational effects become dominant. Only a few of these CSPN have been analyzed so far due to their high luminosity. Their interpretation of their evolutionary status has been hampered by statistical incompleteness.

In the last decade, several spectral analyses of very hot (T_CSPN > 10^5K) post-AGB stars by means of state-of-the-art LTE model atmospheres have been performed (Rauch et al., 1989; Werner 1991; Werner & Rauch, 1994; Werner et al., 1993). In this work, we present the first detailed analysis of the CSPN PG1511+181, a Hot CSPN with a clear detection of the main nebula, weakly brightening polar lobes.

Aims of this investigation

This work aims at:

- spectroscopy and spectral classification of the CSPN
- analysis of the CSPN by means of LTE model atmosphere techniques
- imaging of PG1511 stars: Napiwotzki & Schönberner (1995) analyzed 17 CSPN and found new PG1511 stars
- imaging and spectroscopy of the PN by photometric calibration of the CSPN (telescope) spectroscopy
- analysis of the PN with photoionization models (Köppen 1997)

Observations

We observed the PN PG1511+181 using the CFHT (Law et al., 1993). A few images with medium resolution (R ~ 800) were obtained with the FOSOS C2 and the R1600 grism. The target was imaged in two different bands. The targets are listed in Table 1.

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<td>17.1</td>
<td>18</td>
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</table>

Spectral Analysis of the Central Stars

Medium resolution spectra of all targets but PG241.9+07.8 (R ~ 800) have been taken with FOSOS C1 and the R1600 grism. The exposure times were 3000 sec. We achieved a resolution of about 6 Å. In Fig. 1, the normalized spectra are shown compared with theoretical templates. In the future, this will be impossible to interpret completely the nebula emitting lines [O III] λλ4959, 5007 Å due to strong asymmetries. However, the nebula emission lines could be used to estimate the photosphere of the stars and the NLTE models (Werner 1986).

Imaging of the Planetary Nebula

We took Hα (left) and O[III] λ5007.4 (right) images (exposure time 900 sec) each of all PN from Table 1 with CFHT. The Hα image (ROI 3.3 x 3.3") is shown in Fig. 1. The images are displayed with different cut levels (diam. 25x25")

Fig. 1: Spectra of the central stars of the PN from Table 1. The positions of integrated lines are marked. Note that only the top right spectrum [O III] λ5007.4 is clearly detectable. In the spectra of PG213.8+04.1 and PG226.3+05.4, no Hα line can be detected. Synthetic spectra with T=10,000 K and log g = 7, 6.5 (H α at solar abundance) and T = 10,000 K and log g = 5, 4.5 (pure He) can only give an impression of the surface gravity υ = 100 km/sec (1.4 ± 0.4 km/sec), we achieve almost the same line profiles at this velocity. In the case of PG27.7-28.3, 1+2 denote stars as described in the caption of its image. PG237.7-28.3 shows the reflection spectrum of the binary system.

Results

- Imaging: We detect a [O III] λ5007.4 line in each of the PN. The PN have a clear detection of the main nebula, weakly brightening polar lobes.

- Spectral Analysis: We observe two peaks in the [O III] λ5007.4 line in each of the PN. The PN have a clear detection of the main nebula, weakly brightening polar lobes.

- Acknowledgements: This work was supported by the DFG (Rauch 1999d) and the DFG-DFG (1999d). We thank the CFHT Science Team, the CFHT Staff, and the CFHT Telescope Manager for their cooperation.

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