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FAINT EMISSION LINES IN PLANETARY NEBULAE WITH A [WC] NUCLEUS[1]

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RESUMEN

Presentamos los primeros resultados del análisis de una muestra de 14 nebulosas planetarias con núcleo [WC] con líneas de recombinación débiles de oxígeno y carbono. Los resultados están basados en espectros profundos obtenidos con el espectrógrafo MIKE en el telescopio Magallanes-Clay de 6.5 m en Chile.

ABSTRACT

We present first results from the analysis of a sample of 14 planetary nebulae with [WC] nucleus with detected faint carbon and oxygen recombination lines (RLs). The results are based on deep echelle spectra obtained with MIKE on the 6.5 m Magellan-Clay telescope in Chile.

Key Words: ISM: abundances — planetary nebulae: general — stars: Wolf-Rayet

1. INTRODUCTION

The abundance discrepancy problem is a well known topic in modern astrophysics. Since almost 20 years ago, multiple studies, both in H II regions and planetary nebulae (PNe) have found that ionic abundances of heavy element, such as C and O, obtained from the temperature and density independent ratios of optical recombination lines (RLs) are larger than that obtained following the canonical method, i.e. through the intensity of the strong collisionaly excited lines (CELs), which have a strong dependence with the temperature and in some cases, with density. During last years, several papers have debated the possible origins of this discrepancy, without reaching any certain conclusion (see e.g. García-Rojas & Esteban 2007, and references therein). In PNe, one of the claimed explanations is the presence of H-deficient gas inclusions not fully mixed with the ambient gas of "normal" composition (Liu et al. 2000).

Only a few percentage (∼15%) of the known planetary nebulae (PNe) with studied stellar continuum are ionized by central stars showing Wolf-Rayet features. These stars are H-deficient and they show spectra with wide emission lines of C, O and He due to a strong wind characterized by a high mass-loss rate. They have been designed as [WC] stars. This project is aimed to detect and measure faint RLs of C and O in PNe with central [WC] stars to search for any systematic difference between this type of objects with respect to "normal" PNe. One of the advantages of using heavy element RLs to compute the abundances is that we can derive the C/O ratio for all the objects in our sample. This ratio is usually difficult to derive because there are not carbon CELs in the optical range, and one has to search for UV spectroscopic data in the literature to derive the C abundance. Moreover, an additional objective of this project is to investigate if late evolution events (late or very late helium flashes) in the AGB phase of this stars could be the mechanism that injects the H-deficient gas necessary to explain the ADF in the planetary nebula.

2. OBSERVATIONS

High spectral resolution data were obtained at Las Campanas Observatory (Carnegie Institution) with the 6.5 m telescope Clay and the double echelle spectrograph Magellan Inamori Kyocera Echelle (MIKE) on May, 2006, September 2009 and June 2010. Details on the spectrograph setup and data reduction process can be found in García-Rojas et al. (2009).

3. FIRST RESULTS

We detected and measured between 120 and 350 lines per object – more than 3350 emission lines in total. Most of them correspond to usual CELs and RLs of H I, He I and He II, but we also detected a considerable amount of heavy element RLs, such as O I, O II, O III, C II, C III, C IV and Ne II. Line fluxes

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