ABSTRACT

Stars of PG 1159 spectral type are hot pre-white dwarf stars with atmospheres rich in helium, carbon, and oxygen, that are considered the main progenitors of hydrogen-deficient white dwarfs. Those stars lay in GW Virginis instability strip and some of them show short-period oscillations in photometric observations. In this thesis, we present new ground-based time-series photometric observations of 31 pre-white dwarf stars of PG 1159 spectral type. These observations provide a substantial step towards obtaining the first statistically significant sample of well-studied PG 1159 stars with information about their evolutionary history and excitation of pulsations.

Stellar pulsations driven by the ϵ mechanism were theoretically predicted almost 100 years ago. Theoretical calculations showed that the ϵ mechanism can operate in pre-white dwarf stars with helium-burning shells, giving rise to short-period g modes. One of the candidates to show such pulsations was the central star of planetary nebula VV 47. Observations by various groups did not detect any pulsations in this star, until the detection of pulsations in VV 47 was claimed in 2006. The presence of some high-frequency peaks was attributed to the ϵ mechanism, even though the detection was marginal. We conducted new observations, reaching an improved detection threshold, of VV 47 to test those claims and did not detect any variability. Therefore, we re-analyzed the discovery data set using the same methods as for our new observations, and did not detect the alleged pulsations. We attributed the detection by other authors to a relaxed detection criterion.

Previous observations revealed two groups within the PG 1159 stars: Nitrogen-rich pulsators and N-poor non-pulsators, with one counterexample being PG 1144+005, the only N-rich PG 1159 star with no detection of pulsations. We observed the star and preliminarily detected two pulsation modes consistent with GW Vir pulsations, and confirmed those findings with follow-up observations with a longer time base, characterizing the star as a multiperiodic pulsator. With this study, we confirmed the existence of N dichotomy in PG 1159 stars, with an important conclusion that the pulsating and non-pulsating PG 1159 stars have different evolutionary histories while N is a tracer of these histories, and it seems necessary that a star undergoes a Very Late Thermal Pulse to develop pulsations.

In the years 2014–2022 we carried out an ambitious survey for variability among PG 1159 stars using telescopes of 1 to 10.4-m aperture size located in both Hemispheres. Thanks to newly obtained photometric time-series observations for 29 stars, we discovered pulsations in the central star of planetary nebula Abell 72, variability in RX J0122.9−7529 that can be attributed to pulsations, binarity, or other sources, and put significant limits for non-variability for the rest of the sample. We obtained the most robust fraction of pulsating PG 1159 stars (36%) to date, conclusively proving that the impurity of the GW Vir instability strip is unlikely due to observational bias. We compiled literature data on atmospheric parameters, variability, and nitrogen content of all known PG 1159 stars with

available measurements from *Gaia* DR3, which allowed us to calculate the luminosities and for the first time place all PG 1159 stars in the theoretical Hertzsprung-Russell diagram. Finally, we analyzed the pulsators as a group and questioned currently used nomenclature.

This thesis presents the most complete picture of GW Vir stars that puts us in place to study the whole PG 1159 group. We conclude with a discussion of possible improvements to the work presented here, future prospects for the study of GW Vir stars, and our plans for future work. In particular, in order to fully study the PG 1159 stars as a group, we need to complement the photometric observations with spectroscopy, a project that we have already started.