X SERBIAN CONFERENCE ON SPECTRAL LINE SHAPES IN ASTROPHYSICS
June 15-19, 2015, Srebrno jezero, Serbia
Book of Abstracts, Eds. L. Č. Popović, M. S. Dimitrijević and S. Simić
Astronomical Observatory, Belgrade, 2015

Invited Lecture

DWARF SEYFERT GALAXIES WITH GIANT BROAD LINE REGIONS

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In this invited lecture I will review *Hubble Space Telescope (HST)* spectroscopy of a remarkable popu-lation of dwarf Seyferts with an unusually large broad-line region (BLR). These objects were first identified by Wang & Zhang (2003), and represent a new class of active galactic nuclei (AGN) that have yet to be recognised as such by the astrophysics community. Broad emission lines are a defining characteristic of AGN (Seyfert 1943). They occur in AGNs spanning seven decades in luminosity, from the lowest luminosity Seyferts (Ho et al. 1997) to the highest luminosity quasars. Models proposed to explain the origin of the broad emission lines have one feature in common; fast moving, $\sim$ 5000 km/s, hydrogen gas, located within light-days of a central supermassive black hole (BH, Rees 1977). The models differ only in how the gas achieves its high velocity, be it through inow, outow, spinning in a disk, or attached to stars orbiting close to the BH. Identifying the mechanisms that produce broad emission lines is of paramount importance as only then will we finally be able to understand, and exploit, the physics of the small and as yet, spatially unresolved BLR in AGN. The purpose of this lecture is to highlight an important subset of low luminosity AGNs that are associated with unusually wide Balmer emission lines. These so called dwarf Seyferts (Ho et al. 1997) are remarkable because the width of the Balmer emission lines can, in some cases, rival those seen in the most luminous quasars. Thus, the line widths in these dwarf Seyferts are inconsistent with a simple extrapolation of the BLR size-luminosity relation established by Kaspi et al. (2005) for more luminous AGNs. Rarely does such an obvious dichotomy occur in astronomy, and the result points to a whole new class of AGN. Close inspection with HST reveals emission lines with single peaks, double peaks, and a combination of the two suggesting that the broad emission lines are produced in kinematically distinct regions centered on the BH. Since the gravitational field strength is already known for these objects, by virtue of knowing their BH mass, the relationship between velocity, and radius may be established, given a kinematic model for the BLR gas. In this way, one can determine the inner, and outer radii of the BLRs by modeling the shape of their broad emission line profiles. A remarkable result is the enormous size of the BLRs in some of these dwarf Seyferts. For example, the size inferred for the BLR in the dwarf Seyfert M81 corresponds to an outer radius $\sim$ 1 pc, which rivals the size of the BLR in the luminous quasar, 3C 273, as reported previously by Devereux & Shearer (2007). High quality spectra obtained with the Space Telescope Imaging

Spectrograph will be presented for M81, NGC 3998, NGC 4203, NGC 3227, NGC 4051, and NGC 3516 enabling a determination of the size, structure, and ionization of the BLR in these dwarf Seyfert galaxies.

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