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The CaFe Project: Search for the correlation between Fe+ and Ca+ in active galaxies

Resolving the complexity in Fe II species in quasar spectra has been an ongoing work for over 40 years. First identified and reported for the prototypical Narrow-line Seyfert 1 galaxy I Zw 1 (Phillips 1978a), the study has made a niche of its own in the field of AGN research. Seminal works led by Boroson & Green (1992), Verner et al. (1999), Sigut & Pradhan (2003) and others encapsulate the 'yet to be complete' understanding of the physics of the line formation for this first-ionized state of iron (Fe II). A major part of the puzzle is lent by the sheer number of spectral lines in Fe II than spans across a wide energy range (from UV to NIR). This extended emission seen in the spectra mimics a continuum of sorts, thus the telltale term *pseudocontinuum*.

Gaining knowledge from the past studies and of our own, in this study we search for a reliable proxy to Fe II. This proxy, Ca II, is a much simpler ionic species which is characterized by its triplet in the near-infrared part of an AGN spectrum. The analogous line excitation mechanisms (dominated by the Lyα fluorescence and collisional excitation) for the production of these two species is confirmed by the tight correlation between the respective line strengths that we observe from our *up-to-date collection of coincident measurements in the optical and NIR*, and re-affirmed by our photoionization models. Additionally, our models constrain the physical parameters, such as the required level of ionization and the density of the medium (i.e. the broad-line region) that contain these ionic species, hinting also to the cloud's composition and structure (Panda et al. 2020b; Panda 2020). This study reveals the utility of the Ca II as a proxy for Fe II in ways more than one, primarily, **establishing a new radius-luminosity relation** and in **quasar main sequence studies**.

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