Fast 2-D Photometric Imaging of Elves

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A new multi-anode photometric array imaging device called PIPER (Photometric Imaging of Precipitation of Electron Radiation) has been developed at Stanford University for the purpose of measuring low-light optical ionospheric and atmospheric phenomena. The instrument has been deployed at various locations around the world (including Colorado, Alaska, Virginia, France, and Australia) and has been used in precipitation, auroral, and transient luminous event (TLE) studies.

The PIPER instrument contains four multi-anode photomultiplier tubes arranged in pairs: each pair operates behind a different set of optical interference filters to offer multi-spectral measurements of the same field of view. Each multi-anode photometer pair consists of 16 linearly arranged anodes, each with a detector size of 0.8 mm x 16 mm, yielding the capability for crude spatial resolution in addition to the very high optical sensitivity and temporal resolution typical of photometers. In each photometer pair, one photometer is oriented vertically to achieve vertical spatial resolution while the other photometer is oriented horizontally to achieve horizontal spatial resolution. Interpreted together, the high-speed (25,000 measurements per second per anode) structural evolution of the the field of view at very low light levels can be inferred. This capability is especially suited for imaging elves, and PIPER observation rates of elves have been higher than originally anticipated.

We present the PIPER instrument and discuss its application to the photometric imaging of elves. We discuss several cases of elves observed from Yucca Ridge, Colorado, USA, in the summer of 2007 as well as elves observed during the EuroSprite 2007 campaign.