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Characterization and calibration of compact array spectrometers in the ultraviolet spectral region

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Array-based spectrometers, with their compact size, low weight, low cost, and fast measurement time, are now frequently used in place of conventional single-channel scanning monochromators, and in place of broadband meters when full spectral information is required. The rapid measurement feature makes them an attractive option for routine solar UV spectral measurements, where short-term variability in signal is a challenge. However, compactness, portability, low cost and high speed are achieved at the expense of the optical and electronic performance of the spectrometer. This makes such spectrometers more prone to measurement error from environmental changes, and more prone to other intrinsic sources of error such as stray light and detector non-linearity, which significantly affect solar UV measurements. Corrections for stray light and non-linearity can be managed by either improved optical and detector design or by a detailed spectrometer characterisation.

We present in this paper our investigation of the performance of three different commercial array spectrometers: two mini-spectrometers, and a more elaborate array spectrometer with an onboard image amplifier device. These were tested for a subset of performance parameters: their wavelength accuracy and stability, electronic linearity, responsivity linearity, stray light sensitivity, and mechanical stability and repeatability. With all three spectrometers we found that these parameters, particularly but not limited to stray light, had a significant impact on the measurement of the incoming optical radiation. This meant that without characterisation the instruments would be unable to accurately measure the UV component of any source with significant visible radiation.

We discuss various simple and low-cost solutions for improving the performance of these instruments, and providing a rigorous calibration using a straightforward set-up including optical filters and the quasi-monochromatic light from a double monochromator.