The Prevalence of O IV Density Diagnostics in UV Burst Spectra

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Abstract

We present a study of O IV density diagnostics in the far ultraviolet (FUV) spectra of UV bursts. UV bursts appear as compact, short-lived brightenings observed in active regions. The FUV spectra of UV bursts exhibit peculiar properties that suggest they are signatures of magnetic reconnection deeply embedded in the cool solar chromosphere; these include intensification and broadening/splitting of emission lines, the presence of optically thin Si IV 1393.8/1402.8 Å emission lines that form at transition region temperatures ($\geq 80,000$ K), and the presence of absorption features from cool metallic ions (Ni II 1393.3 Å and Fe II 1392.8 Å). Improving our understanding of these bursts will give us insight into how they contribute to the heating of the lower solar atmosphere. In particular, it is important to constrain the formation altitudes of these events, which can be estimated via lower-bound measurements of electron densities using O IV and Si IV emission lines. However, it is unclear how often the forbidden O IV 1401.2 Å line appears in UV burst spectra due to its potential to extinguish at high electron densities as a result of collisional de-excitation. This work will determine how often this critically important spectral feature arises in UV burst events. We locate UV bursts in AR11850 over nine observations from 24-27 September 2013 using data from the Interface Region Imaging Spectrograph (IRIS), which provides simultaneous imaging and spectroscopic data of the upper chromosphere and transition region in the far and near ultraviolet (NUV). We detect UV bursts by applying a four-parameter single-Gaussian fit to the Si IV 1393.8 Å emission line. We perform cuts in the 4-D parameter space to isolate the UV burst population, then we manually inspect the remaining spectra for signs of Ni II 1393.3 Å absorption. We use the resulting sample to look for instances of the O IV 1401.2 Å emission line. With the intent of obtaining a distribution of its statistical significance, we measure the total integrated intensities and their uncertainties for each O IV line associated with a UV burst. We find that 33.62% of the sampled O IV lines have signal-to-noise ratios above 3.0, which demonstrates that electron density and altitude estimates are possible for a sizable fraction of UV bursts.

Keywords: Solar activity, Solar chromosphere

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