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Search for optimal PDF'S for Na released by photons from solid surfaces

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Desorption of Na from planetary surfaces, like Mercury and the Moon, by solar photons are important processes for filling surface-bound exospheres. We investigate the adequacy of three model speed distributions functions that have been previously used in several studies to describe the desorption of atoms from a solid surface either by electron or by photon bombardment, namely: the Maxwell-Boltzmann (M-B) distribution, the empirical distribution proposed by Wurz et al. [2010] for PSD (E-PSD), and the Weibull distribution. We use all the available measurements reported by Yakshinskiy and Madey [2000, 2004] to test these model distributions and determine which one fits best (statistically), we discuss their physical validity, and the possible extension to other surface temperatures. Our results, using the Graphical Residual Analysis (GRA), show that the measured speed distributions of released Na atoms are too narrow compared to the "high" temperature M-B fits used by Yakshinskiy and Madey [1999, 2000, 2004]. A good fit with M-B is only achieved with an offset of the whole distribution to higher speeds and at a lower temperature, yet showing no correlation with the surface temperature. On the other hand, the Weibull distributions are ostensibly better fits for which an increase in the temperature to that of the surface is not needed, though an offset towards higher speeds is required. The GRA shows that the M-B fits are statistically less adequate compared to the other non-Maxwellian distributions, not to mention that the M-B are not physically applicable to this kind of experiments. The GRA also shows that the Weibull distribution is particularly better suited to the measurements and the parametrization has a better physical interpretation. Our results confirm that Electron-Stimulated Desorption (ESD) and Photon-Stimulated Desorption (PSD) should produce non-thermal speed (energy) distributions of the atoms released via these processes, which is expected from surface physics.