Predicting the Strength of Solar Flares using Sunspot Characteristics

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This project focuses on predicting the strength of solar flares based on sunspot characteristics. It was hypothesized that the probability of generating an intense solar flare within a sunspot increases as the size and magnetic complexity of the sunspot increases. The Mount Wilson Classification system categorizes sunspots into alpha, beta, beta-delta, beta-gamma (BG), and beta-gamma-delta (BGD) based on magnetic properties. Alpha sunspots are considered to be the least complex, whereas BGD are the most complex. Solar flares are ranked by the amount of x-rays emitted, ranging in intensity from B to the severest X class. For this experiment 100 B, C, and M class flares were analyzed along with 22 X class solar flares. As hypothesized, the greater the size and magnetic complexity of a sunspot, the higher the probability of an intense solar flare event. It was observed that BGD sunspots with areas 200 μSH and smaller had a 0% generation of X class flares, whereas BGD sunspots with 600 μSH and greater had a 30.2% generation rate. This trend was consistent with B, BG and BGD type structures. A significant change in the behavior of sunspots occurs at 600 μSH and greater sunspot size. Sunspots above 600 μSH did not exhibit alpha and beta sunspot magnetic characteristics. It is now understood that only BD, BG, and BGD sunspots have the potential to produce X class flares. This research aids in understanding the relationship between these two solar phenomena but also advances current solar flare forecasting models.