Detection limits for close sub-stellar and planetary companions to WDs in the WASP survey

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We have performed extensive Monte Carlo simulations to explore the possibility of detecting transits of sub-stellar and planetary companions to WDs in SuperWASP light-curves. Due to the small radius of WDs ($\sim$1R$_\oplus$) any brown dwarf or gas giant companions will totally eclipse it, and even smaller bodies (e.g. Moon) will yield transits detectable in good signal-to-noise light-curves (*depth* $> 1\%$). Our simulations cover an as yet unexplored parameter space for companions with $\sim 0.3\mathrm{R}_\oplus < R_{\rm pl} < 12\mathrm{R}_\oplus$ and with orbital periods P between 2 h and 15 d (for a between $\sim$0.003 and 0.1 AU). We used our implementation of the Box-Least Square algorithm (BLS) to recover injected transit signals, and we found that for Gaussian random noise SuperWASP is sensitive to companions as small as the Moon, orbiting a $V \sim$12 WD. For fainter stars SuperWASP is sensitive to increasingly larger radius rocky bodies. We find that in the presence of correlated noise structure in the light-curves our sensitivity drops. However, Earth-sized companions remain readily detectable even in low S/N data. Mars and even Mercury-sized bodies might yield reasonable detection rates in high-quality light-curves with little residual noise. We searched for eclipses and transit signals in a sample of 194 WDs resulting from a cross-correlation of the McCook & Sion catalogue and the SuperWASP archive. No evidence for sub-stellar and planetary companions were found. We used this non-detection and results from our simulations to place robust upper limits to the frequency of planetary companions to WDs in our sample. While no useful limits can be placed on the likely frequency of Moon sized or smaller companions to WDs, we place stronger constraints on BD and Gas giant companions with periods < 10 day, which must certainly be rare ($< 1\%$). To place similarly stringent constraints on Earth-size bodies at similar orbital distances would require WD samples which are at least a factor of 10 larger.