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Optimizing exoplanet transit searches

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Abstract

Exoplanet searches using the transit technique are nowadays providing a great number of findings. Most exoplanet transit detection programs that are currently underway are focused on large catalogs of stars with no pre-selection. This necessarily makes such surveys quite inefficient, because huge amounts of data are processed for a relatively low transiting planet yield. In this work we investigate a method to increase the efficiency of a targeted exoplanet search with the transit technique by preselecting a subset of candidates from large catalogs of stars. Assuming spin-orbit alignment, this can be done by considering stars that have higher probability to be oriented nearly equator-on (inclination close to 90°). We use activity-rotation velocity relations for low-mass stars to study the dependence of the position in the activity - $v \sin(i)$ diagram on the stellar axis inclination. We compose a catalog of G-, K-, M-type main sequence simulated stars using isochrones, an isotropic inclination distribution and empirical relations to obtain their rotation periods and activity indexes. Then the activity-vsini diagram is filled and statistics are applied to trace the areas containing the higher ratio of stars with inclinations above 80°. A similar statistics is applied to stars from real catalogs with $\log(R'_{\rm HK})$ and $v \sin(i)$ data to find their probability of being equator-on. We present the method used to generate the simulated star catalog and the subsequent statistics to find the highly inclined stars from real catalogs using the activity-$v \sin(i)$ diagram. Several catalogs from the literature are analysed and a subsample of stars with the highest probability of being equator-on is presented. Assuming spin-orbit alignment, the efficiency of an exoplanet transit search in the resulting subsample of probably highly inclined stars is estimated to be two to three times higher than with a global search with no pre-selection.