

## Abstract

An open star cluster is an accumulation of young stars, typically localised inside the galactic plane. The individual stellar winds in open star clusters can aggregate to a stronger cluster wind. Charged particles – typically protons – can be accelerated to high velocities by diffuse shock acceleration in the cluster's strong wind. If these fast protons collide with other protons, a neutral pion can be produced, which then most commonly decays into two photons. If the velocity of the original proton is sufficient, this process can create high-energy gamma rays. According to TeVCat, three star clusters are associated with gamma ray sources, namely Westerlund 1 and 2 and Cygnus OB2. Another star cluster inside Westerhout 43 is also likely to be associated with a gamma ray source. The following hypotheses were used to select star clusters from the GAIA-DR2 star cluster catalogue by Lei Liu and Xiaoying Pang (October 2019) as the basis of a search for as-yet unknown associations between clusters and sources: The cluster should have an age below  $13 * 10^6$  years and contain more than 200 stars. The catalogue lists 2443 star clusters, of which 92 young clusters with large numbers of stars were selected. These hypotheses and potential size thresholds were then investigated. A search for the nearest gamma sources of the H.E.S.S. and HAWC catalogues in proximity of the selected clusters, limited to a maximum angle of  $0.6^\circ$ , resulted in the identification of four of the 92 selected clusters as having a source nearby. To investigate the threshold for the number of stars, young (less than  $13 * 10^6$  years) clusters with fewer than 200 stars were studied in terms of their two-dimensional spatial proximity to gamma sources. Eleven of the 349 star clusters selected were found to have a gamma source nearby. To analyse the effect of the cluster size, the young, star-rich clusters were divided into large (at least 30 pc in radius) and small (at most 10 pc in radius) clusters. The two-dimensional spatial proximity of these to gamma sources was then investigated. One of the 18 small and none of the 24 large star clusters were found to have a source nearby. Analysis of the parameters of the four young and star-rich and eleven young star clusters with few stars with a close source determined that for a cluster to be associated with a gamma ray source, the following parameters have to be fulfilled: The cluster should have an age under  $10 * 10^6$  years, more than 100 stars and the radius should be between 8.5 and 15 pc. From a further analysis of the known cluster – gamma ray source pairs in terms of separation and two-dimensional spatial geometry it was possible to narrow down the original results to two probable pairs: Namely, the star cluster ID 1222 with source HESS J1841-055; and the star cluster ID 1613 with source HESS J1614-518.