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Long-Term Supernova Monitoring with HALO

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Supernovae are the favoured location in the universe for certain processes necessary for the formation of heavy elements, and the only location where the effects of neutrino-neutrino scattering could plausibly be observed. This makes supernovae relevant to the fields of both nuclear astrophysics and particle physics.

A core collapse supernova can be detected by the immense burst of neutrinos it produces. For this reason, HALO (Helium And Lead Observatory) was built to detect supernova neutrinos by capturing neutrons released from lead nuclei when struck by neutrinos. The use of lead as a target material gives the detector a unique sensitivity to electron neutrinos, where as other detectors predominantly see electron anti-neutrinos. The different neutrino flavor distributions could provide information about the structure and mechanics of the core-collapse.

HALO will be joining the SNEWS (SuperNova Early Warning System) in the near future. SNEWS is a network of neutrino detectors around the world that will send an alarm to the astronomy community when a galactic supernova is detected. The surface of a supernova does not explode until the shock wave from the core collapse reaches it, which takes a few hours. Because of this delay, SNEWS can inform astronomers of a supernova before it is visible, which will hopefully allow for a supernova to be observed from its very beginning for the first time.

HALO is expected to run continuously for decades in order to detect a supernova. This is important because most other detectors in the SNEWS network are not primarily focused on supernovae, and as such may be shut down for refurbishments aimed at other physics goals when a supernova occurs. An "always on"detector will remove the possibility that SNEWS misses a galactic supernova.

HALO currently has a burst monitor running at low thresholds to learn more about the types of background events occurring in the detector. The most notable of these are Spallation events, caused by muons splitting lead nuclei. These events release bursts of neutrons with multiplicities well above the supernovae detection threshold, but they can be very cleanly discriminated due to their short duration and more spacial clustering in the detector. Other types of instrumental bursts are also noted and analyzed.

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