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Unpinning of superfluid vortices through (quasi) neutron-vortex scattering and pulsar glitches

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The model of pinning and unpinning of superfluid vortices is considered the most popular explanation behind pulsar glitches. However, the reason behind the almost instantaneous unpinning of a large number of vortices still needs a proper mechanism. We proposed that the neutron-vortex scattering in the inner crust of a pulsar may be responsible for such vortex unpinning. The strain energy released by the crustquake is assumed to be absorbed in some part of the inner crust. It causes pair-breaking quasi-neutron excitations from the existing free neutron superfluid in the bulk of the inner crust. The scattering of these quasi-neutrons with the vortex core neutrons should unpin a large number of vortices from the thermally affected regions and result in pulsar glitches. We consider a few geometries of the affected pinning region to study the implications of the vortex unpinning in the context of pulsar glitches. We find that a Vela-like pulsar can release about $\sim 10^{11} - 10^{13}$ vortices by this mechanism and results in glitches of size $\sim 10^{-11} - 10^{-9}$. We also explored the possibility of a vortex avalanche triggered by the movement of the unpinned vortices. An estimate of the glitch size caused by an avalanche shows a favourable result. The time scales associated with various events are compatible with glitch observations.

Session

Astroparticle Physics and Cosmology

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