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Vortex Avalanches in Neutron Stars

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Rotational glitches can result from the angular momentum exchange between the curst and neutron star interiors. We study the dynamics of about 600 quantum vortices in a spinning-down two-dimensional neutron superfluid using the Gross–Pitaevskii model. For the first time, we find convincing spatial-temporal evidence of avalanching behaviour with about 10-20 vortices in each event resulting from vortex depinning and collective motion, during glitches and their post-evolutions. In the later stage, vortices continue to depin and circulate around the vorticity void in a similar manner to that seen in previous point-vortex simulations. We also demonstrate the exponential and power-law distributions in the avalanche waiting time and size under a controllable setup. Lastly, we comment on the challenge of extrapolating these results to conditions in real neutron stars, which contain many orders of magnitude more vortices.

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