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# Intermediate mass elements in young supernova remnants reveal neutron star kicks by asymmetric explosions

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The birth properties of neutron stars (NSs) yield important information about the still debated physical processes that trigger the explosion as well as on intrinsic neutron star physics. These properties include the high space velocities of young neutron stars with average values of several 100km $s^{-1}$, with an underlying " kick" mechanism that is not fully clarified. There are two competing possibilities that could accelerate NSs during their birth: anisotropic ejection of either stellar debris or neutrinos. Here we present new evidence from X-ray measurements that chemical elements between silicon and calcium in six young gaseous supernova remnants are preferentially expelled opposite to the direction of neutron star motion. There is no correlation between the kick velocities and magnetic field strengths of these neutron stars. Our results support a hydrodynamic origin of neutron-star kicks connected to asymmetric explosive mass ejection, and they conflict with neutron-star acceleration scenarios that invoke anisotropic neutrino emission caused by particle and nuclear physics in combination with very strong neutron-star magnetic fields.

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