W15a How much SNR fallback can invade newborn pulsar wind and magnetosphere?

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Young Neutron Stars (NSs) in the Galaxy with ages of $t_{age} <$ 1-10 kyr are categorized into three classes: non-recycled pulsars, magnetars and central compact objects (CCOs), where the reason for this diversity is still unknown. A peculiar point of CCO is its significantly small dipole magnetic field, while one of the important processes that may be responsible for this is the fallback accretion onto the newborn NS: If the fallback accretion proceeds down to the near surface region, the magnetosphere of the newborn NS can be strongly disturbed. But meanwhile, its rotation energy can be extracted by the unipolar induction as a strongly magnetized relativistic outflow, which confronts with the fallback matter. If the outflow repulses the fallback matter, the central NS successfully evolves into a rotation-powered pulsar; otherwise a CCO with buried magnetic field is expected. In this research, we will focus on the bifurcation between CCO and other types of NSs by investigating a collision between a marginally bounded inflow and a relativistic fireball outflow, resembling to supernova fallback accretion onto newborn pulsar wind through 1-D Relativistic Hydrodynamics simulation. We found that the inner-most position the fallback matter could reach $r_{fb,min}$ mainly depends on the energy flux ratio between fireball outflow and falling-back inflow ζ, and the minimum outflow luminosity the central NS needs to produce a non-CCO decreases with the encounter radius r_{enc} of in- and outflow increases. We apply this results to the Crab-like Pulsar and point out that it may at around the bifurcation point of NS sequences.