The primary role of jets in powering core-collapse supernovae

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Abstract and Summary

(1) Core-collapse supernova (CCSN) remnants show that jets explode most (probably all) **core-collapse supernovae.**
[In addition, the JJEM explains CCSNe of all explosion energies and has no failed supernovae; these are compatible with observations. The neutrino mechanism fails on all counts.]

(2) It is time the community considers the **Jittering-Jets Explosion Mechanism (JJEM)** on an equal level to the competing delayed-neutrino explosion mechanism.

Two 2025 examples of community ignoring the JJEM and highly overrating the neutrino mechanism:

(a) In a chapter for the Encyclopedia of Astrophysics (arXiv:2503.01321), the 3 authors cite themselves over 50 times but do not mention the JJEM. The authors and the two editors refused my request to mention the JJEM (which has about 20 refereed papers just in 2024-2025).

(b) Within half a year, in 4 supernova meetings (Padova, ESO, Warsaw, Stockholm), supporters of the neutrino-mechanism were invited speakers, with no appropriate presentation of the JJEM (at least in the first three meetings, JJEM researchers were allowed to be present). This is a cultural aspect of a religion, not a scientific one. I call for scientific debates instead of priests preaching to the believers.

Method

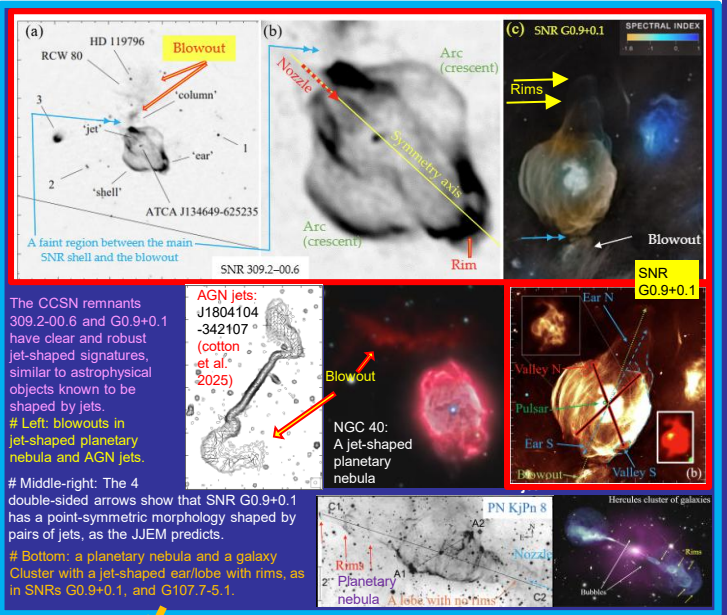
We use the same extremely common and fully acceptable method to study **active galactic nucleus feedback**, the shaping of **planetary nebulae**, and **HH objects of young stellar objects**.

(1) Observationally identify opposite pairs of morphological features that strongly suggest jets: **bubbles, lobes, clumps, nozzles, and ears** (poster by Dima Shishkin).

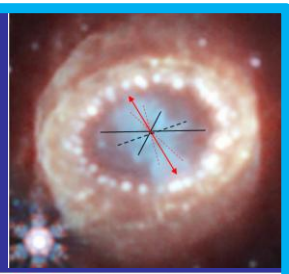
(2) Simulate manually launched jets (Braudo et al. 2025).

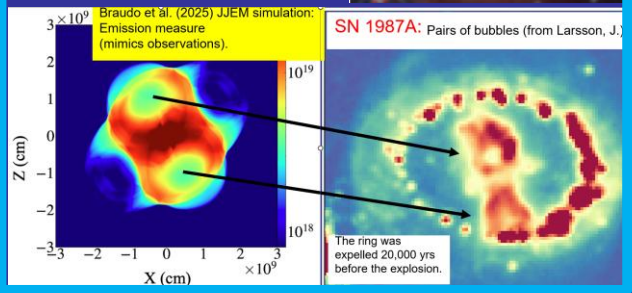
(3) Compare simulations with observations.

(4) Compare CCSN remnants to astrophysical objects known to be shaped by jets.

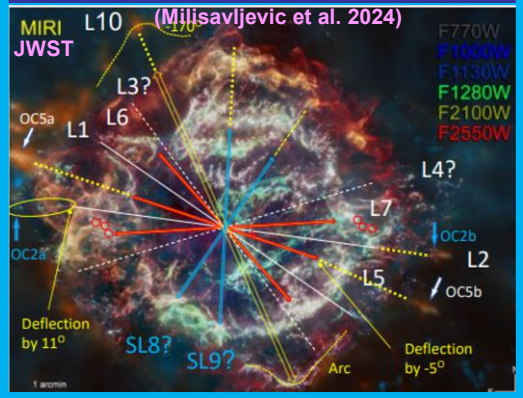


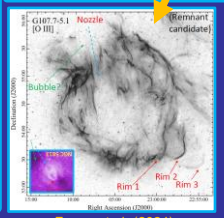
SN 1987A revealed a point-symmetric morphology composed of clumps (right) and a bipolar structure (bottom). The bipolar structure is tilted in three dimensions, but so are many other jet-shaped bipolar structures in planetary nebulae and clusters of galaxies.





Cassiopeia A is a clear case of a point-symmetrical CCSN that only jittering jets can explain (Bear & Soker 2025).





Fesen et al. (2024)

There are 15 point-symmetric CCSN remnants. For more, see the poster by **Dmitry Shishkin**