On Supernovae

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A supernova begins with core-collapse and the resulting emitted electron neutrinos, which are insufficient by a wide margin to account for stellar disruption. The rapidly rotating neutron star produces a supraluminal excitation in the surrounding plasma, beyond the pulsar light cylinder, where polarization currents are updated faster than the speed of light. The radiation resulting from nearly a third of each full annulus of this excitation initially focuses on its own single point tangent to the light cylinder, corotates with the pulsar spin rate, f revolutions/s, and then migrates out of the rotational plane, occupying the surface of a cone of polar half angle, arcsin(c/v), where c is the speed of light, and v is the speed of the excitation, i.e., v=2πfR, with R as the annulus radius. Thus this electromagnetic process produces a force/shock outward from the light cylinder, which accelerates plasma, produces nuclear burning, and transmutes elements in the r-process. At greater radii, the initial focus on the light cylinder suffers from absorption by the dense, intervening plasma of the stellar core, but the path to the rotational poles avoids much of the core, and here the focus easily accelerates polar jets. For core-core or white dwarf-white merger-core-collapse events, a weakly magnetized (few GigaGauss) neutron star is formed rotating at 500 Hz. Supernova 1987A and nearly all other recent supernovae have resulted from this process. For core-collapse of solitary, massive stars, a strongly magnetized (few TeraGauss) neutron star is formed rotating only near 60-80 Hz, but solar masses of ^{56}nickel can be formed from thermonuclear fuel uncontaminated by helium. Supernovae 1986J, 2006gy, and 2007bi are examples of this type of SN. As the progenitor is progressively disrupted, the collimation of the pulsar-driven jets decreases, until finally, very little plasma is left.

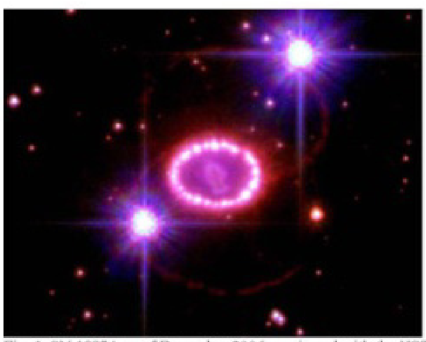
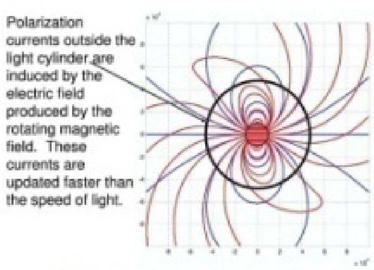
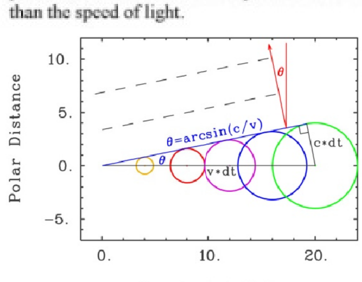


Fig. 1. SN 1987A as of December 2006, as viewed with the HST (NASA, P. Challis, & R. Kirshner, Harvard-Smithsonian Center for Astrophysics). North is up, east is to the left. The axis of the bipolarity corresponds to the "Mystery Spot" bearing of 194° (the far-side [southern] minor axis of the equatorial ring has a bearing of 179°). The pulsar within this remnant (and all other remnants as well) caused this bipolarity (see further below).

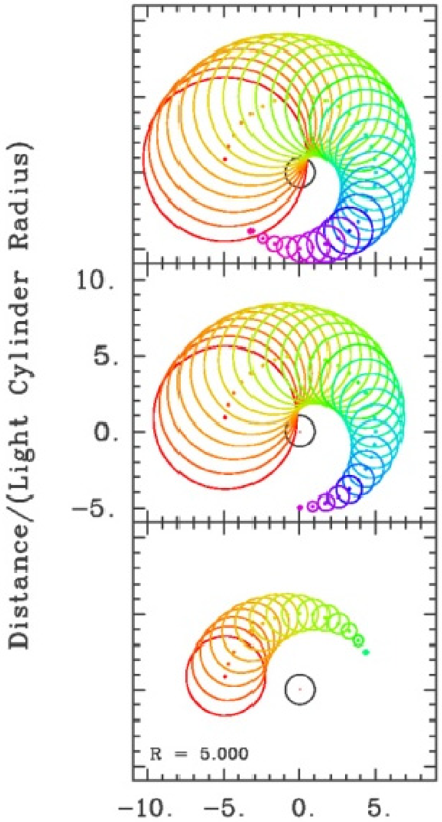


(Blue – non-rotating. Red – rotating clockwise.)

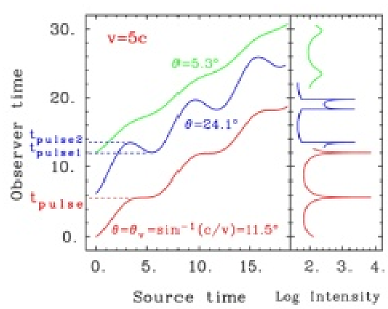
Fig. 4. A rotating, magnetized body produces a periodic disturbance, even beyond its light cylinder, which, if there is plasma available, induces polarization currents that are updated at a rate faster than the speed of light.



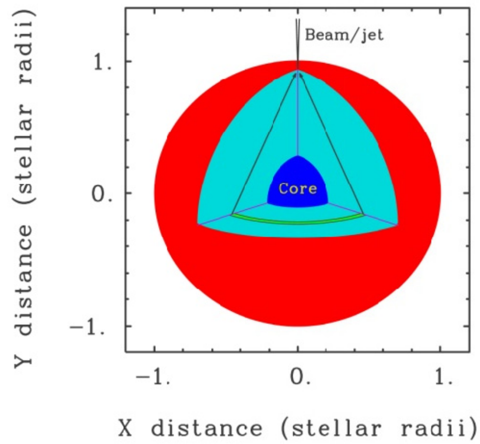
Huygens' wavelets of a supraluminal disturbance (v=5c) propagating from right to left form two fronts, each with a polar angle of arcsin(v/c). Emission in these directions (two circles on the sky) decays only as 1/distance.



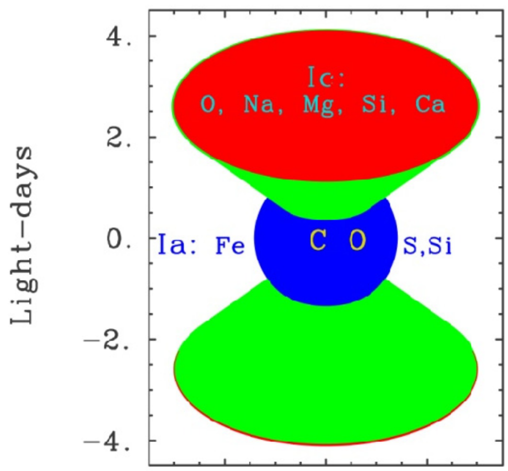
Huygen's wavelets for a polarization current source rotating counterclockwise at 5 times the light cylinder radius (v=5c), starting at 9:10 o'clock (bottom frame, left largest red circle), and ending at 7 o'clock (top frame, magenta dot), produce a pattern of emission which is initially focused (a "cusp") on its light cylinder (inner black circle) at 11:30 o'clock (middle frame), and then progresses to 12:30 o'clock (and eventually out of the plane with time at a polar angle of arcsin (c/v). The range of sources (dots), contributing to the cusp, runs from red into green and eventually into blue (9:10 o'clock to 3 o'clock). This is a rotation-powered pulsar. If v=100c (plasma at 100 light cylinder radii), this is a supernova. If you get in front of this, you, and a lot of starguts, will end up going very, very fast.



For the lower curve, a time source of finite dimension (1) contributes to a single time (dimension 0) for an observer. Thus the intensity of the pulsations, in the direction represented by this curve (the "cusp" -- polar angle θ_v) only as 1/distance, and this goes on *forever* for the cusp – the further away the observer, the more source contributes to the signal. For observers at larger polar angles, as for the middle curve, two still narrow peaks are observed in the pulse profile, and the intensity drops with the usual 1/distance^2 law. At smaller polar angles (top curve), the pulse profile consists of only a broad, weak, single peak.



Annuli with radii larger than the stellar core radius (green) have a relatively unimpeded influence on the rest of the star, including the poles, where the timing relation (and decay only as 1/distance) drives strong, highly collimated polar beams and jets.



The pulsar remnant in SNe Ia/c transmutes elements through the r-process while driving these (Na, Mg, Ca) in polar jets, even in or near the stellar photosphere. This happens because carbon and oxygen are available there (as they are throughout the rest of the progenitor). SLIP is the only SN model which accounts for the lines of r-process elements observed even in very early spectra of SNe Ic.

Conclusions

The model of pulsar emission by supraluminally induced polarization currents (SLIP) provides a means by which spinning neutron stars can disrupt their progenitor stars and drive highly collimated polar beams and relativistic jets. These can account for SN 1987A's beam, jet, and "Mystery Spot," the bipolarity of all other SNe, the jets of Sco X-1 and SS 433, the multi-GeV e^+ excess, the r-process, and possibly star formation in the early Universe without dark matter. In particular, the lines of r-process elements of SNe Ic confirm SLIP as its driving mechanism in or near the progenitor photosphere at the poles (as well as other locations). SLIP also predicts that gamma-ray burst afterglows will be pulsars, which enforce a toroidal geometry on the equatorial ejecta. This geometry and mechanism apply to all SNe observed so far, which makes it extraordinarily difficult to calculate, or to establish a representative local sample of any type of SNe, including Ia's. Because local SNe Ia's were selected on the basis of obeying the width-luminosity relation, in which the e^+e^- γ-rays were well encapsulated, this sample must lie at the high end of the range in mass, and hence is too luminous to be representative of a distant sample which could not be so carefully selected. The most likely interpretation of SNe Ia data is that there is no anomalous dimming of the distant sample, and therefore ***no direct evidence at all for the existence of dark energy***.

This work was supported in part by Los Alamos National Laboratory LDRD grants 20080085DR and 20110320ER.