Pulsar-driven Jets and the Non-existence of Dark Energy and Matter

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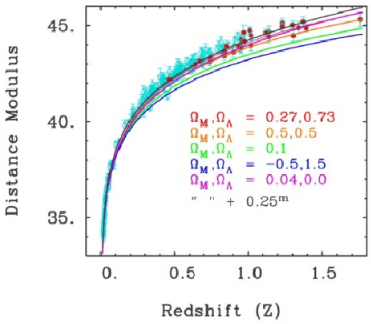
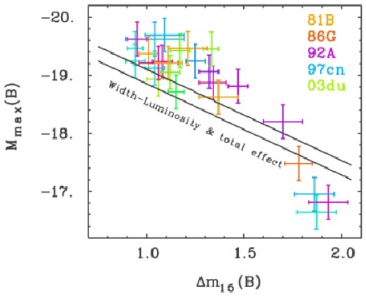
The bipolarity of Supernova 1987A and other SNe can be understood in terms of its very early light curve as observed from the CTIO 0.4-m telescope, as well as the IUE FES, and the slightly later speckle observations of the "Mystery Spot" by two groups. These observations and the resulting kinematic solution support pulsar emission from polarization currents induced beyond the pulsar light cylinder by the periodically modulated (at many times the speed of light) electromagnetic field (supraluminally induced polarization currents – SLIP). With plasma available at many times the light cylinder radius, as would be the case for a spinning neutron star formed at the center of its progenitor, pulsed emission is directed close to the rotation axis, eviscerating this progenitor remnant, and continuing for months to years, until very little circumpulsar material remains. There is no reason to suggest that this evisceration mechanism is not universally applicable to all SNe with gaseous remnants remaining, forcing SNe into a geometry consisting of two polar jets and an equatorial torus, of which the former almost never encapsulate ^{56}Ni e^+/e^- γ-rays well, and the latter, in the case of SNe Ia, only for those with the largest mass in excess of that lost to core-collapse. A large fraction of SNe Ia will therefore lie considerably below the width-luminosity relation, complicating their usefulness as standard candles in cosmological interpretation, and possibly accounting for their apparent anomalous dimming with distance. Pulsar-driven jets from the SNe of the first stars also allow star clusters to form without the need for dark matter. SLIP also accounts for GRBs, the Sco X-1 and SS 433 jets, LMXBs, and predicts that GRB afterglows are 100% pulsed at ~500 Hz/(1+z).



The cosmological constant and mass contributions derived from distant SNe Ia are extraordinarily sensitive to the calibration of the luminosities of local SN Ia. There is also very little difference between Ω_Λ, Ω_M = 0.73, 0.27 and 0.0, 0.04, and a small 0.25 magnitude decrease in the local luminosity more than erases the difference between the two cosmologies.



The only hope for standardizing the local sample of SNe Ia was that they would all adhere to the width-luminosity relation. But then Benetti et al. found in 2005 that this was not the case. By 2007, SNe Ia were found "all over the map," even in the lower middle part of the above figure (where none are shown). That was the end of only direct evidence that the expansion of the Universe is accelerating. A few choice quotes from the 2007 SN conference about this: "… a little bit of 'the emperor has no clothes,'" "We keep saying the same thing, but the evidence for it doesn't get better, and that's a bad sign." "There's a lot of holes in the story."

Why did this fail?
Because of the very nature of SNe!
Start with SN 1987A:

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).

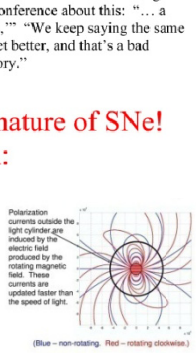
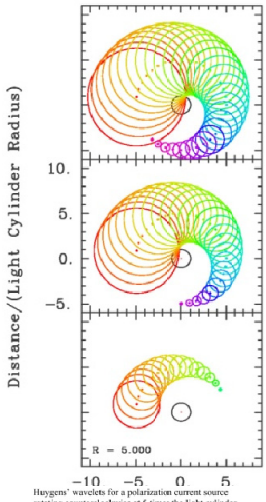
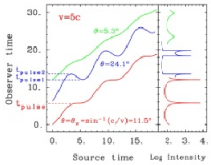


Fig. 4. A rotating, magnetized body produces a periodic disturbance, even beyond its light cylinder, which, if there is plasma available, induces polarization currents that are updated at a rate faster than the speed of light.

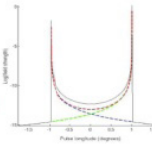


Huygens' wavelets for a polarization current source rotating counterclockwise at 5 times the light cylinder radius (v=5c), starting at 9:10 o'clock (bottom frame, left largest red circle), and ending at 7 o'clock (top frame, magenta dot), produces a pattern of emission which is initially focused (a "cusp") 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 with an angle of $\sin^{-1}(v/c)$). 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 starcats, will end up going



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_o) 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.

In the SLIP model, the pulse profile comes from the same 3 sources. These produce the typical, cusped, doubly-peaked profile, and predict that all singly-pulsed profiles are actually doubles.



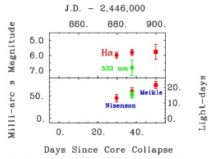


Fig. 10. Measurements of displacement (lower) and observed magnitude (upper) of the "Mystery Spot" (MS) from SN 1987A, at Hα and 533 nm, vs time, from Nisenson et al. 1987, ApJ, 320, L15, and Meikle et al. 1987, Nature, 329, 608.

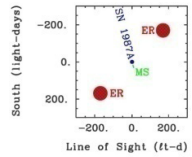


Fig. 12. The approximate path of the "Mystery Spot" (MS) relative to SN 1987A and the equatorial ring (ER -- shown in cross-section).

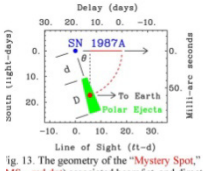


Fig. 13. The geometry of the "Mystery Spot," MS – red dot) associated beam/jet, and direction of sight from SN 1987A. It takes an extra δ days for light from 87A to hit the polar ejecta PE – an extra *13* days to the PE midpoint), and proceed on to the Earth. The distance from 87A to the MS, at day 30, is ~20 light-days. An offset by the 0.5° half collimation angle of a jet over this distance would delay the flux by about 100 s, the characteristic delay for long duration, soft spectrum GRBs (ℓGRBs).

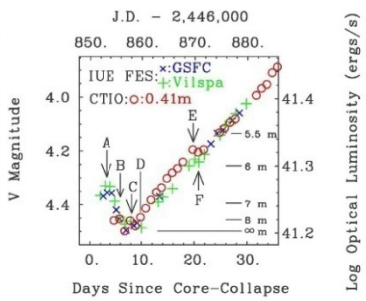


Fig. 11. After Hamuy & Suntzeff 1990, AJ, 99, 1146, and Wamsteker et al.1987, A&A, 177 L21, the very early luminosity history of SN 1987A as observed with the CTIO 0.41-m and the Fine Error Sensor of IUE. Data taken at Goddard Space Flight Center by Sonneborn & Kirshner, and the Villafranca Station in Madrid, are marked as blue x's, and green +'s, respectively. Various stages of beam/jet breakout and interaction with polar ejecta are labeled. The flux level near day 20 corresponds to 5.8 magnitudes above the day 7 minimum, the *same* (see Fig. 10) as that of the MS in Hα measured nears days 30, 38, and 50.

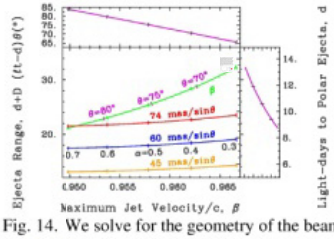
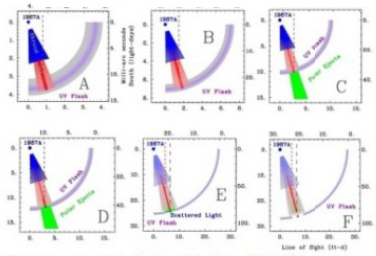
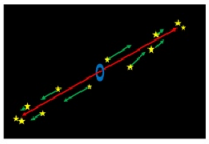


Fig. 14. We solve for the geometry of the beam/jet (green curve) from SN 1987A (as diagrammed in Fig. 13) using the constraints shown in Figs. 10 and 11. Here α is the fraction of the way through the polar ejecta that the Mystery Spot had penetrated at day 37.8 when its projected offset from SN 1987A was 0.060 arc s. The solution for α=0.5 gives:

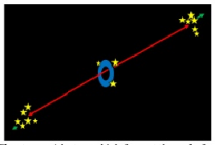
θ = 75.193°,
d = 10.47738 ℓt-d,
D = 14.888 ℓt-d,
β_{max} = 0.9578.



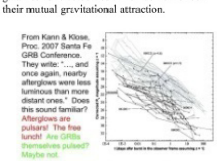
The progression of the beam and jet from SN 1987A for times corresponding to Fig. 11. At 'A' the beam and jet expand freely. By 'B' the jet expands and cools, or loses the ability to do so, resulting in a diminishing luminosity. At 'C' the beam impacts the polar ejecta (PE) and reprocesses, producing an impulse of light. By 'D' the jet has penetrated into the PE, producing another uptick of light following the decay of the 1st uptick at day 7.8. By 'E' the beam has broken through the PE and scattered light produces yet another uptick of light around day 19.3 or so. In another day, the jet has cleared the PE, resulting in a decrement of the light near day 20.8. The 1 day lag out of in 20 means that the fastest jet particles are moving at 95% of the speed of light.



Do the jets from the pulsars produced by the 1st SNe allow the formation of galaxies within 500 million years? Maybe! They do trash a lot of entropy between stars. They inhibit star formation locally, but space is vast, and the pulsar-driven plumes (aka "Mystery Spot"), in addition to inducing star formation in lines along their paths, may plough up enough material to form stars at their endpoints.



The streams/clusters which form at the end of the jets retain a small fraction of the initial jet velocity (~0.2 c), which may explain the results from GALEX, where near pairs of distant galaxies have velocities which do not reflect their mutual gravitational attraction.

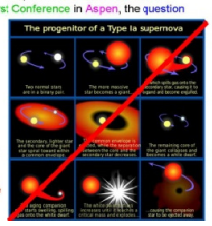


Pulsars, ALL!

Fig. 24. The premier prediction of the SLIP model is that gamma-ray burst afterglows will be essentially 100% pulsed.

The Demise of the Single Degenerate Paradigm

At ~5:30 p.m., on 21 Feb. 2007, at the SN 1987A 20 Years After, and Gamma-ray Burs: Conference in Aspen, the question was posed: Is there any way of avoiding double-degenerate for these objects [Type Ia SNe]? There was no answer. Kirshner, Wheeler, & Fillipenko were all there. They also haven't said anything since then. This means that the thermo-nuclear mass left over from the merger can go to ZERO! No standard candle there until there's enough to encapsulate the ^{56}Ni e^+e^- γ-rays.



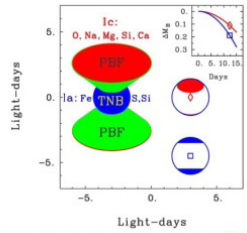


Fig. 25. In supernovae, the pulsar blows out the poles (PBF -- left hand figure), and it doesn't stop doing that until there is no material remaining around it. This is catastrophic to cosmology by Type Ia SNe, because the pulsar forces the thermonuclear ball (TNB) to remain *toroidal* for *all* of the lifetime of the SN, allowing much of the positron annihilation gamma-ray flux to escape from a much higher mass TNB than previously thought. In addition, the width-luminosity magnitude drop is smaller than expected (still smaller than the red curve plotted in the upper right frame) because of the exposure of the rear, forward-looking face of the toroid, as the PBF thins in the weeks past maximum light of the SN.

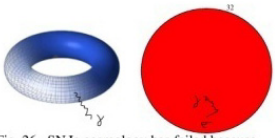


Fig. 26. SN Ia cosmology has failed because the equatorial toroid allows γ-rays to escape more readily than a spheroid of the same volume. Also, the material in excess of that lost to core-collapse can go to 0. Thus a population of Ia's exists that is not bolometric, and contaminates distant, but not local, samples.

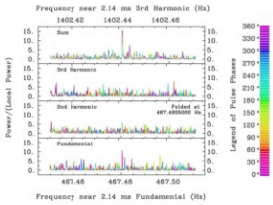


Fig. 23. The 2.14 ms signal (top = fundmental + 2nd harmonic), from observations with the Mt. Canopus 1-m Tasmania, was consistent with the LCO 2.5-m Wratten 87 magnitude of 21. After 1993, August 23, the probability that the 2.14 ms signal was not real was 10^{-10}. The fact that the pulsar is not visible now, in spite of any amount of wishful thinking on the part of many, only means that it ran out of plasma, and has entered the Cas A phase. That is the *boundary condition* for these objects, as 99% of SNe, near enough to tell, show no evidence of a non-thermal source at late times (1986J is the exception). The real questions to be answered were: Did a pulsar ever appear, and if so, when and why, and what did it do to the progenitor star? The

Conclusions

The model of pulsar emission by superluminally induced polarization currents (SLIP) provides a means by which spinning neutron stars can drive a highly collimated beam and relativistic jet which 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 LMXBs, the multi-GeV e^- excess, and possibly star formation in the early Universe. It predicts that gamma-ray burst afterglows will be pulsars, and that the pulsars within SNe will literally eviscerate the gaseous remnant into two polar jets and enforce a toroidal geometry on the remainder of 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 the local sample of Ia's was selected on the basis of obeying the width-luminosity relation, in which the e^+e^- γ-rays were well encapsulated, this sample undoubtedly lies 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***. And if dark energy goes, then there's no longer any sleazy numerical coincidence to argue for dark matter, so that goes as well. There is likely ***NO DARK STUFF*** affecting the Universe for the last 8 billion years, when gravity didn't matter and Ω_{Total} ~ 0.04, even though Ω_{Total} = 1.0 at the era of recombination, when gravity did matter – this is a deeper problem than many have been willing to admit.

The path to the intimate and productive study of the SN and GRB processes is now clear: with high time resolution of GRB afterglows, we let the Universe reveal the behavior of the pulsars responsible (including even core collapse events of the first stars), through the selection effect of the inverted distance law (flux ~ 1/distance) operating across billions of light years.

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