Another Look at the Pulsar Phenomenon

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Astronomers have recognized in the pulsars, the extremely compact pulsating stellar objects, opportunities to test the correctness of the predictions of different theories of gravitation. In fact, the substantial amount of accurate observations accrued on the binary pulsar PSR 1913+16 by J. H. Taylor et al.[1,2] brings this goal nearer to achievement. It is, therefore, possible to test the Reciprocal System on the basis of the information now available on PSR 1913+16 and other pulsars.

According to the Reciprocal System, a pulsar is the ultra-high-speed product of a Type II supernova explosion—the result of reaching the upper rotational limit of matter. In *Quasars and Pulsars*[3] Larson gives a brief account of the origin and characteristics of pulsars. Arnold Studtmann in his doctoral dissertation *Towards a Unified Cosmological Physics*[4] gives a critique of Larson's theory of pulsars. A study of these raises some issues that need clarification.

1. Firstly: we recall that quasars, too, like the pulsars, are the result of gigantic Type II explosions which impart sufficient speed to carry them past the neutral point and into the region of motion in three-dimensional time. The overcoming of the gravitation that gives rise to the pulsation phenomenon is present in the quasar situation as well. As such, the reason why the pulse phenomenon is not apparent in the case of quasars must be explained.

2. If Larson's account of the pulse mechanism is correct, it can be seen that the duration of each pulse cannot be more than a few natural units of time (n.u.t.), at the most, beyond the point where gravitation has decreased to half of unit value. But such a conclusion is not consistent with the observed fact, since the pulse widths range from about 5 to 30 milliseconds. For instance, at the point where gravitation is down to 0.500, half of the radiation from the ultra high speed explosion product is observable in space and the other half is unobservable. We thus receive radiation for 0.152×10^{15} seconds, after which there is a quiet interval of 0.152×10^{15} seconds, then another flash of radiation, and so on.[5] Here it is important to note that the fraction to which the unit gravitational speed is reduced gives the ratio of the pulse duration to the pulse period. Thus, in the above example, when gravitation has come down to 0.5, we find that there is radiation for a duration of one n.u.t. succeeded by a quiet interval of one n.u.t. Thus the period is two n.u.t., and the ratio of pulse duration to pulse period is 1 n.u.t./2 n.u.t. = 0.5.

   Now suppose that gravitation has come down to 0.4. In this case, as far as the radiation is concerned, the proportion of the spatially active time units to the spatially inactive time units is 0.4 to 0.6. Since there are no fractional units, we find that there will be a radiation pulse for a duration of 2 n.u.t., followed by a quiet interval of 3 n.u.t., yielding a pulse period of 5 n.u.t.—the *smallest* whole number of n.u.t. possible. However, the ratio 2/3 of the spatially active to the spatially inactive units is not the only one which is equal to the ratio 0.4/0.6. The ratios 4/6, 6/9, 8/12, etc. are all mathematically equal to it. But the 2/3 ratio is the most probable one since it involves the least number of consecutive units of any one kind, spatially active or spatially

1 *Scientific American*, May 1979, p. 75.
2 J. M. Weisberg et all., *Scientific American*, Oct. 1981, p. 66.
3 Larson, Dewey B., *Quasars and Pulsars*, North Pacific Publishers, Portland, Oregon, 1971, p. 159.
4 Studtmann, Arnold D., *Toward a Unified Cosmological Physics* (1979).
5 Larson, Dewey B., *Quasars and Pulsars*, *op. cit.*, pp. 166-67.

inactive, in continuous succession. Thus, as the gravitation goes on attenuating, the pulse period increases, but the pulse duration does not grow, being constrained by the discrete unit postulate and the probability principles. By the time the pulse period has grown to an observationally detectable size, the pulse duration remains in the range of one n.u.t. to a few femtoseconds. But this conclusion is at variance with the actual observed pulse widths. Neither Larson nor Studtmann points out this discrepancy.

2.1 One way to get over this problem seems to be by realizing that the magnetic explosion which drives the stellar matter to the superluminal speeds does not impart those speeds to all parts of the affected material at the same instant of time. Presumably the inception of the explosion takes place at the center of the star and spreads to the outer layers at the speed of light. Consequently, different portions of the star enter the region of motion in three-dimensional time at different instants. This engenders a phase difference among the radiation pulses given out by these various portions, while their respective pulse periods will be the same, since the period is determined by the degree of attenuation of the gravitation and not by the epoch of their reaching the gravitational limit. Thus the observed pulse can be seen to be the result of juxtaposing individual subpulses (from the different portions), each of duration not more than a few femtoseconds.

A total pulse width of 10 milliseconds, say, implies that the portion of the original stellar material that became the pulsar is of radius

$$(10\times10^{-3}\text{ sec}) \times (2.99793\times10^{5}\text{ km/sec}),$$

equal to 0.0043 solar radii; the outlying material being dispersed into space to form the SNR (supernova remnant). This does not mean that only material within a radius of 3000 km underwent the catastrophic explosion. The explosion might continue to larger radii, but the speed imparted to it becomes less than is necessary to transport the matter to the region of three-dimensional time. Thus, knowledge of the pulse width will enable one to estimate the fraction of the original star's mass that went into the pulsar.

3. The next difficulty with Larson's account of the pulse mechanism concerns the occurrence of two separate peaks in the pulses of many pulsars (like CP 0834, CP 1133, NP 0532, PSR 1913+16, etc.) No explanation has been offered for this from the framework of the Reciprocal System. In the conventional lighthouse model, the double peak is explained by suggesting that the pulsar beam is a hollow cone and the peaks could be the two sides of the cone sweeping past our earth. Though this suggestion is perfectly legitimate, the process whereby such a hollow cone beam of polarized radiation can be generated in the pulsar is far from being understood.

3.1 Two ways of accounting for this pulse structure seem possible in the context of the Reciprocal System. Larson points out that the distribution of emitted radiation takes place two-dimensionally "…when (it) originates in the region of ultra high speeds, where physical action takes place only in two scalar space-time dimensions, and not in 3-dimensional space or time."[6] Furthermore, this is also the reason for the radiation to be polarized, as it is constrained to the two dimensions. It is not clear why Larson, while asserting both the two-dimensional distribution of radiation and its polarization in the case of the quasars, highlights only the polarization aspect with nothing more than a passing reference to the planar emission in the case of the pulsars.

6 *Ibid.*, p. 100.

The double peak can easily be explained if the pulse production is regarded as being due to the 2-dimensional distribution of the pulsar radiation coupled with the fact of the rapid spinning of the pulsar. Two peaks are the result if the angle between the spin axis and our line of sight is greater than the angle of tilt of the radiation plane relative to the spin axis.

3.2 The second alternative is the explanation offered in item 2.1, above. As the total pulse is seen to be made up of an ensemble of phase-shifted micropulses originating from different zones that are transported to the realm of motion in 3-dimensional time at different moments, the general shape of the pulse gives an idea of how the explosion progressed.

Obviously the first material to reach superluminal speeds is that nearer the center of the star where the explosion begins. In the normal course, the explosion spreads radially outward in an expanding spherical shell. Therefore, as the explosion progresses, the quantity of the material involved in the explosion increases nearly as the square of the radius, in the initial stages, with the consequent rise in the magnitude of the explosion. This manifests itself as the corresponding increase in the amplitude (luminosity) of the successive subpulses, starting from zero. However, as the explosion front progresses to larger radii it encounters material at lower and lower densities—the decrease in the density eventually more than offsetting the increase in the spherical area. This results in a fall in the intensity of the explosion and shows up as a decrease in the amplitude of the successive subpulses.

However, if the size of the exploding star is very large, the above phenomenon is modified. The densities in such a star in the regions beyond the initial parts of the explosion are greater compared to a star of smaller size. Under these conditions, the advancing compression wave due to the explosion in the inner regions is usually sufficient to raise the material density at a larger radius and to step up the strength of the explosion again, resulting in the second peak. It may also be noted that in such a case the height of the second peak has normally to be less than that of the first. In the case of a smaller star the second peak does not occur for the reason that the pressure wave simply ejects the low density matter in the outer layers outward, forming the remnants.

The Type II supernova, which is the origin of the pulsar, is the result of reaching an age limit. This also means that the general size of the star is comparatively large (due to accretion) and hence the double peak in the pulse need not be a rare feature. As already remarked, the shape of the pulse is the signature of the explosion. With a knowledge of the density profiles in stars and the kinetics of the explosion it is not difficult to calculate the critical size of the star necessary to produce two peaks in the pulse. Since, as already noted, the pulse duration gives an idea of the radius of the parent star involved in the explosion, it is possible to estimate the mass of the pulsar, its radius, period of rotation, density, luminosity, and average temperature.

4. Lifetimes

4.1 The next difficulty is concerning the calculations of the lifetimes. In *Quasars and Pulsars* Larson explains that the pulsar is continuous until the inner gravitational limit is reached in the explosion dimension. Beyond this distance there is a pulsation with an increasing period. There is also another distance, the outer gravitational limit, beyond which there is no gravitational effect at all and hence the pulsar is not visible as it "leaves the material sector" of the universe. In the *Structure of the Physical Universe* Larson evaluates these two gravitational limits for a star of one solar mass as being 2.26 and 13,350 light years respectively. Consequently, he points out that the life of a one-solar-mass pulsar is limited to about 13,000 years.

Further, as the continued attenuation of the gravitation—which is responsible for the gradual increase of the pulse period—is related to the inverse square of the distance traveled (in time) Larson arrives at the following relation between the period P and the age A:

$$P = KA^2$$

where K is a constant. Since both the age and the period of the Crab Nebula pulsar, NP 0532, are known, he calculates the value of the effective inner gravitational limit in the case as being 6×10^{-5} light years.[7]

The inner and outer gravitational limits of a star of m solar masses are respectively given by

$$d_0 = 2.26\ \sqrt{m} \text{ and } d_1 = 13350\ \sqrt{m} \text{ light years.}$$

Therefore, their ratio:

$$d_1/d_0 = 13350/2.26 = 5907.1$$

is seen to be independent of the mass. Thus the outer gravitational limit in the above case of NP 0532 works out to be

$$d_1 = 5907.1 \times (6\times10^{-5}) = 0.354 \text{ light years.}$$

This means that its life is limited to 0.354 years, of 130 days! Thus there is an unresolved incompatibility between the requirement of a small inner gravitational limit as little as 6×10^{-5} light years (to account for the pulsar's present period) and the requirement of an outer gravitational limit as being nearly 13350 light years (to account for the lifetime).

4.2 Studtmann[8] estimates the masses of several pulsars on the basis of a relation involving the maximum possible age of a pulsar. For example, the maximum pulse period, for the Vela pulsar, PSR 0833, is computed to be 5.2345 seconds. Then on the basis of $P = KA^2$ relation, the A<max> of PSR 0833 is calculated to be

$$1503 \times (5.2345/0.0892)^{1/2} = 11514 \text{ years}$$

where 0.0892 seconds is its present (1969 value) pulse period at the age of 1503 years. Comparing this maximum age with that of a one solar mass pulsar, namely 13350 years, he calculates the mass of PSR 0833 as $(11514/13350)^2 = 0.74$ solar masses.

However, there is an inconsistency in the calculations. This stems from the fact that the present age of the Vela pulsar, 1503 years, used in the above computation is, in the first instance, arrived at in an earlier calculation[9] on the basis that its mass is one solar mass. To be precise, the fact that the value of the constant K in $P = KA^2$ is dependent on the mass of the pulsar seems to have been overlooked. The period P_0 of the pulsar at an age A_0, when it just arrived at the inner gravitational limit d_0, is one n.u.t. Since $d_0 = A_0$ (when the former is expressed in light years and the latter in years)[10] we have

$$A_0 = 2.26\ \sqrt{m}$$

7 *Ibid.*, p. 169.
8 Studtmann, Arnold D., *Toward a Unified Cosmological Physics*, *op. cit.*, p. 595.
9 *Ibid.*, p. 588.
10 *Ibid.*, p. 591.

(see item No. 4.2 above). Thus

$$K = P_0/A_0^2 = 1.52\times10^{-16} / 2.26^2 \text{ m}$$

Moreover, it will be seen that if $P = KA^2$ is to be true, the maximum possible period, whatever might be the pulsar's mass, turns out to be

P<max> = $(13350/2.26)^2 \times 1.52\times10^{-16} = 5.31\times10^{-9}$ seconds!

Once again the inference seems to be that the inner gravitational limit of 2.26 light years is too large.

4.3 The next difficulty of the same category is concerning the time derivative of the period, P. Studtmann[11] describes how Larson, from the three relations, $P = KA^2$, A is inversely proportional to P<effective>, and P<effective>^{3} = P<measured>, concludes that P<measured> is inversely proportional to P raised to the power of 1.5. But since age A is time, from $P = KA^2$ we have $P = 2KA$. How A is taken to be inversely proportional to P is not clear.

5. Pulsar Gravitation

5.1 The next category of difficulty is about the pulsar gravitation. Do pulsars exhibit additional redshift like the quasars, which according to the theory arises out of the motion in time?

5.2 Because of the ultra high range of speeds imparted to the pulsar material, the material is expanding in time and the gravitation that seems to be acting is gravitation in time. If pulsar gravitation is in time, it is not clear how a pulsar can ever form a binary system (like PSR 1913 + 16, for example).

5.3 Further, it must be recalled that gravitation is an inward scalar motion *inherent* in the very scalar motion forming the material atoms. So long as the material type of atomic rotation is extant, it is not clear how the concomitant gravitation can be anything other than spatial. In the case when the gravitation in space is completely offset by the speed imparted by the explosion, it must be recognized that the explosion speed can only counteract the *translational* aspect of the gravitation, and cannot nullify the positive scalar *rotation* much less convert it to the negative rotation of the cosmic atoms which is the source of the gravitation in time. Consequently, even though the two extra units of speed transport the material into the cosmic sector where the gravitation in time is operative, the atoms with the material type rotation cannot form aggregates in 3-dimensional time—they move outward in time as well as space.

6. Explaining the pulsing at X-ray frequencies occurring in the case of some pulsars, Larson says "… accreted low-speed matter will interact with the adjacent portions of the pulsar, and will reduce the speed of some of its constituent particles below the unit level, causing the emission of x-rays … Inasmuch as all of the three types of radiation, radio, X-ray, and optical, originate in the rapidly moving pulsar, the pulsation rates will be the same for all."[12]

But the retarding of the superluminary matter to the region below unit level (thereby causing X-ray emission) will also eliminate the cause for the pulsing phenomenon, since in that speed range radiation is emitted continuously, that is, in every unit of clock time.

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11 *Ibid.*, p. 592.

12 Larson, Dewey B., "Astronomical X-ray Sources," *Reciprocity* V № 1, March 1975, p. 3.

6.1 It is suggested that, on the other hand, the x-ray emission could be the result if some portions of the pulsar material are *accelerated* from the 2-x speed range to the 3-x range, since this speed range brings the motion back into space again (in the second scalar dimension).

7. Larson states: “At this … 0.500 distance, half of the radiation from the ultra high speed explosion product is observable in space and the other half is unobservable.”[5] This description, I think, can be misunderstood by imagining that though the other half of the radiation is unobservable in space, it nevertheless exists. But this is impossible because the photons of radiation, having no independent motion, progress scalarly outward at unit speed and are observable either from the material sector or from the cosmic sector. “The other half” which Larson refers to as being “unobservable” must be radiation which *was never emitted*. The term “radiation observable in space” could be misleading too.

   In his *Structure of the Physical Universe*, Larson very clearly explains the mechanism of the emission of radiation, making use of the Principle of Inversion. “From this principle we find that the thermal motion of the atoms of matter is in equilibrium with a similar vibratory motion of the space units in which they are located… and as space-time progresses it carries this vibrational motion of the space units along as radiation.”[13] The atoms enter new space units as they are moving inward in space (while space-time is progressing outward), and these new units also acquire the vibration and become photons.

   So long as the material atoms are continuously moving from one space location to another (in the inward direction) by virtue of their gravitational motion, each successive space unit traversed turns into a photon, and the radiation is continuous. If the radiation is to be intermittent—as in the case of the pulsars—this can happen only if the motion of the atom is intermittent. For instance, in the example cited by Larson, where the gravitation is down to 0.500, the atoms move inward to the adjoining space unit in one unit of time and in the next unit of time their movement is coincident with the background space-time progression. From the foregoing it can be seen that if L_0 is the luminosity calculated from the Stefan-Boltzmann Law, the actual luminosity L is proportional to L_0/P where P is the pulse period, because the energy leaves the atoms only intermittently. If this argument is legitimate it must lead to the correct theoretical identification of the relationship between the radio luminosity and the period.

13 Larson, Dewey B., *The Structure of the Physical Universe*, (North Pacific Publishers, 1960), p. 119.