THE MAGNETAR ORIGIN OF PULSARS

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This work suggests the idea that all neutron stars experienced at birth an ultrafast decay of their magnetic fields from their initial values to their current surface values. If the electromagnetic energy radiated in this decay is converted into kinetic energy then this conversion of energy predicts that radio pulsars are born with magnetic fields typical of magnetars.

$$P=\frac{2\ddot{\mu}^2}{3c^3},$$

LARMOR FORMULA

$$\mu_0=B_0R^3/2$$

$$\ddot{\mu}\sim\mu_0/\tau^2$$

$$P\simeq\frac{B_0^2R^6}{6c^3\tau^4}$$

POWER RADIATED BY NS OF RADIUS R AND INITIAL FIELD Bo

$$\tau_s=\frac{R}{c}\ln(B_0/B_s)$$

TIME DECAYING FROM Bo to Bs

$$\tau=R/c$$

SHORTEST TIME FOR ACCELERATING NS

$$\mathcal{E}_{\rm rad}\simeq\frac{1}{6}B_0^2R^3\ln(B_0/B_s)$$

RADIATED ENERGY BY NS DURING THE TIME τ_s

$$\frac{1}{6}B_0^2R^3\ln(B_0/B_s)=\frac{Mv^2}{2}$$

ENERGY CONSERVATION OF NS

$$B_0=B_s\,e^{W(6Mv^2B_s^{-2}R^{-3})/2}$$

INITIAL MAGNETIC FIELDS OF NS

$$v=\left(\frac{B_0^2R^3\ln(B_0/B_s)}{3M}\right)^{1/2}$$

BIRTH VELOCITY OF NS

$$v=a\frac{R}{c}\ln(B_0/B_s)$$

ALTERNATIVE FORM

$$a=\left(\frac{B_0^2Rc^2}{3M\ln(B_0/B_s)}\right)^{1/2}$$

INITIAL ACCELERATIONS OF NS

$$v_\perp=kB_0\sqrt{\ln(B_0/B_s)}$$

TRANSVERSE VELOCITY OF NS

$B_0\approx1.75\times10^{15}$G
MAGNETAR
J1809−1943
$B_s=2.10\times10^{14}$G
$v_\perp=227$ km/s

$B_0\approx6.29\times10^{14}$G
PULSAR
PSR J2144-3933
$B_s=1.9\times10^{12}$G
$v_\perp=135$ km/s

$B_0\approx2.57\times10^{14}$G
MILLISECOND PULSAR
$B_s=2.59\times10^{8}$G
$v_\perp=85$ km/s

$$\frac{1}{6}B_0'^2R^3\ln(B_0'/B_s)=\frac{Mv^2}{2}-\frac{4\pi^2MR^2}{5}\left(\frac{1}{P_s^2}-\frac{1}{P_0^2}\right)$$

ENERGY CONSERVATION INCLUDING ROTATIONAL ENERGY

$$P_0=\sqrt{\frac{24M\pi^2R^2P_s^2}{5P_s^2(B_0'^2R^3\ln(B_0'/B_s)-3Mv^2)+24\pi^2MR^2}}$$

INITIAL PERIOD OF NS