AN ATTEMPT TO SATISFY WERNER'S WISH

OR:

HOW WELL DO WE UNDERSTAND PULSARS?

Wolfgang Kundt, Bonn, 17.5.2006

ASSUMPTIONS:

(1) PULSARS DIE, STATISTICALLY, AT $P/2\dot{P} = 10^{6.4}$ yr. MT

(2) PULSARS BLOW STRONG (LEPTONIC, ER) WINDS, $\approx 10^4 \cdot 2\pi R_{pc}^2 \cdot \varrho_{HB} \cdot c$, $\Rightarrow$ STRONG NEUTRAL EXCESS.

(3) PULSAR MAGNETIC FIELDS ARE $\approx$ DIPOLES, STABILIZED BY A TOROIDAL BANDAGE, $\approx$ DIPOLE + 2^3POLE + 2^5POLE + ... MR

(4) PULSAR POLAR CAPS CARRY A PAIR CORONA, (FROM BOMBARDMENT BY DOWNWARD CURRENTS).

INFERENCES:

(1) THE DISCHARGES ABOVE POLAR CAPS ARE AC, NO 'GAPS', NO GLOBAL CIRCUIT, SMALL COROTATING ZONES.

(2) PULSARS DIE WHEN THEIR WIND PRESSURE DECREASES BELOW A CRITICAL VALUE, WHEREUPON THEIR CSM AVALANCHES DOWN, AND THROTTLES THEIR MAGNETOSPHERE.

$P_{CSM} \leq L/4\pi r^2 c \approx \ddot{\mu}_\perp^2/6\pi r^2 c^4 \sim \Omega^4/r^2$,

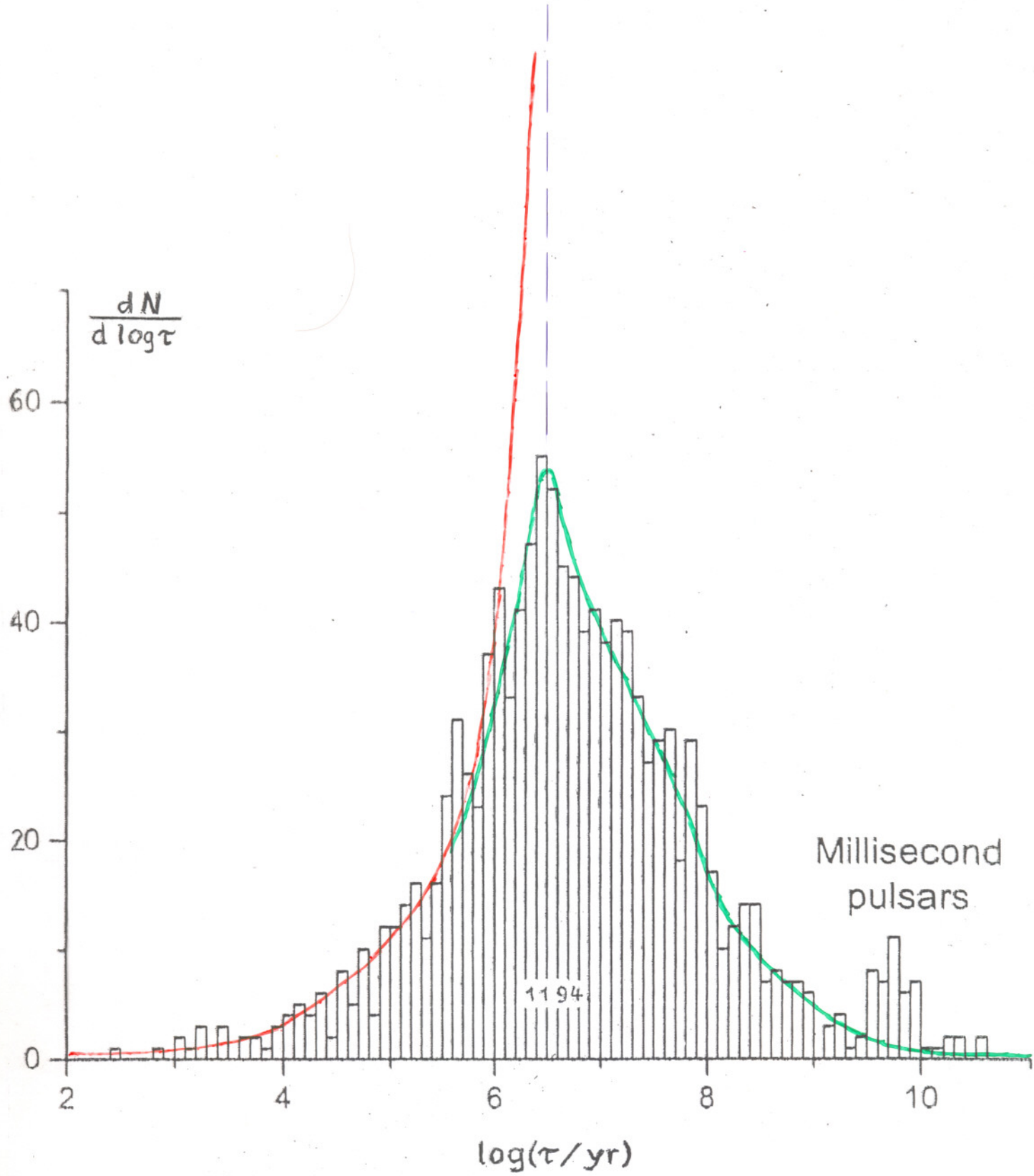
$$\boxed{P \geq 8\,\mathrm{s}\,(\mu_{31}\, T_3/\sqrt{P_{-12.3}})^{1/2}}, \quad r_{cav} \geq GMm/2kT = 10^{14.9}\,\mathrm{cm}/T_3.$$

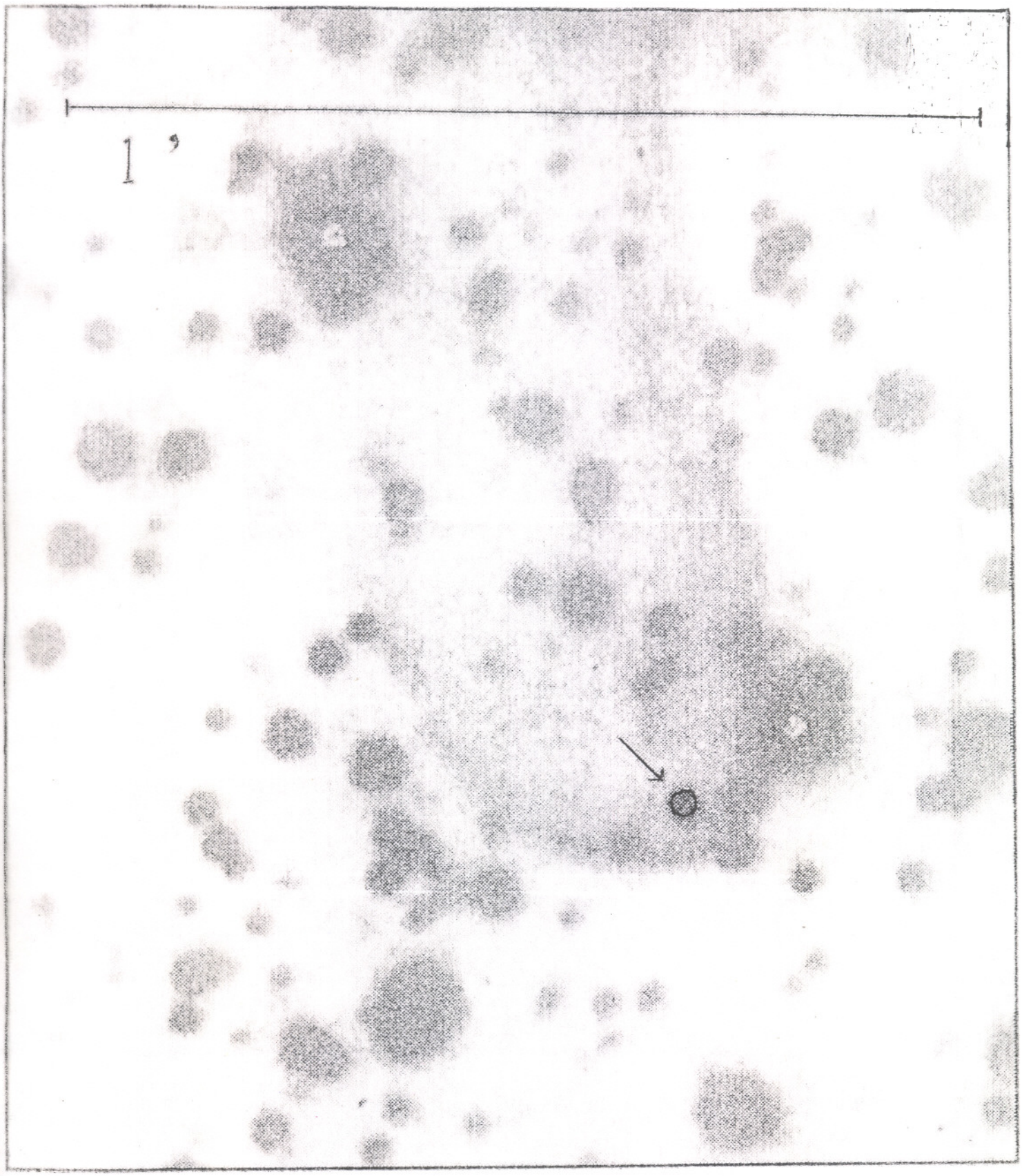
WE OBSERVE THESE THROTTLED PULSARS AS MAGNETARS, WITH $B_{surf} < 10^{14}$ G, AND/OR AS RRATs. AL

(3) THESE THROTTLED PULSARS ARE ALSO THE SOURCES OF THE (HIGHEST-ENERGY) COSMIC RAYS, AND OF THE (QUARTER DAILY) GRBs, INCLUDING THE SGRs.

(4) ALL PULSARS ARE BORN FAST, (NO RECYCLING).

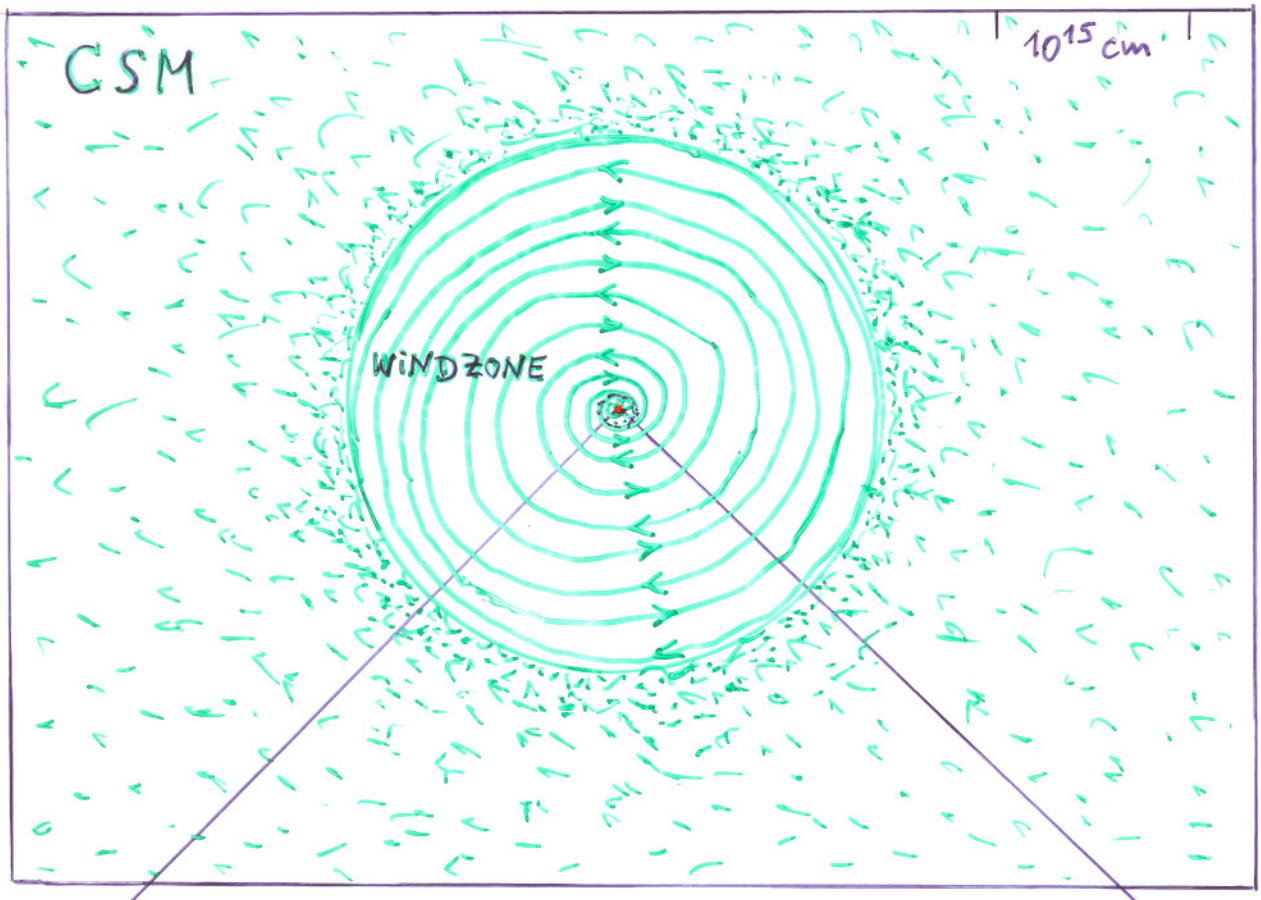
(5) THE ms PULSARS CAN BE QUITE YOUNG.


dN / d log τ
60
40
20
0
2
4
6
8
10
log(τ/yr)
1194
Millisecond pulsars

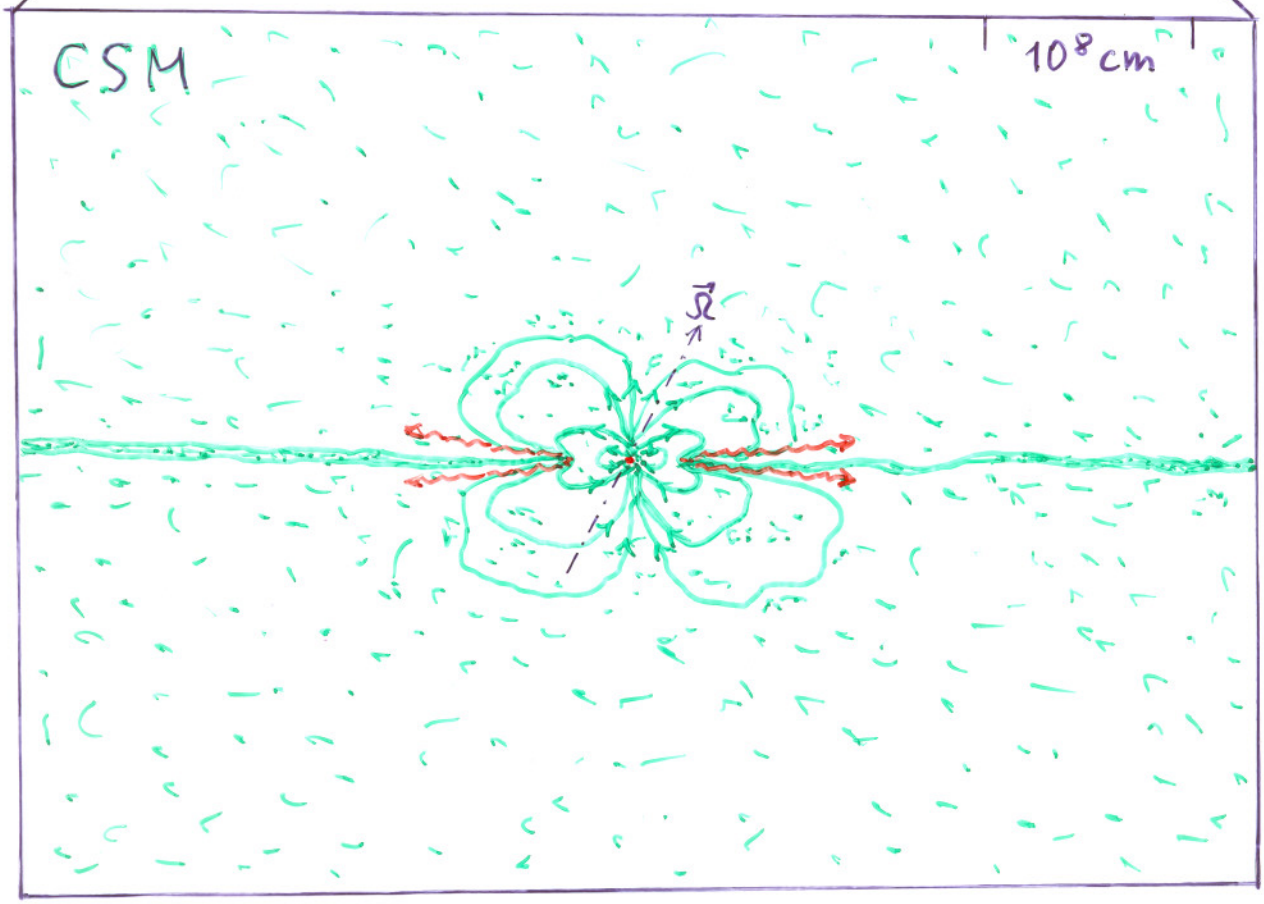


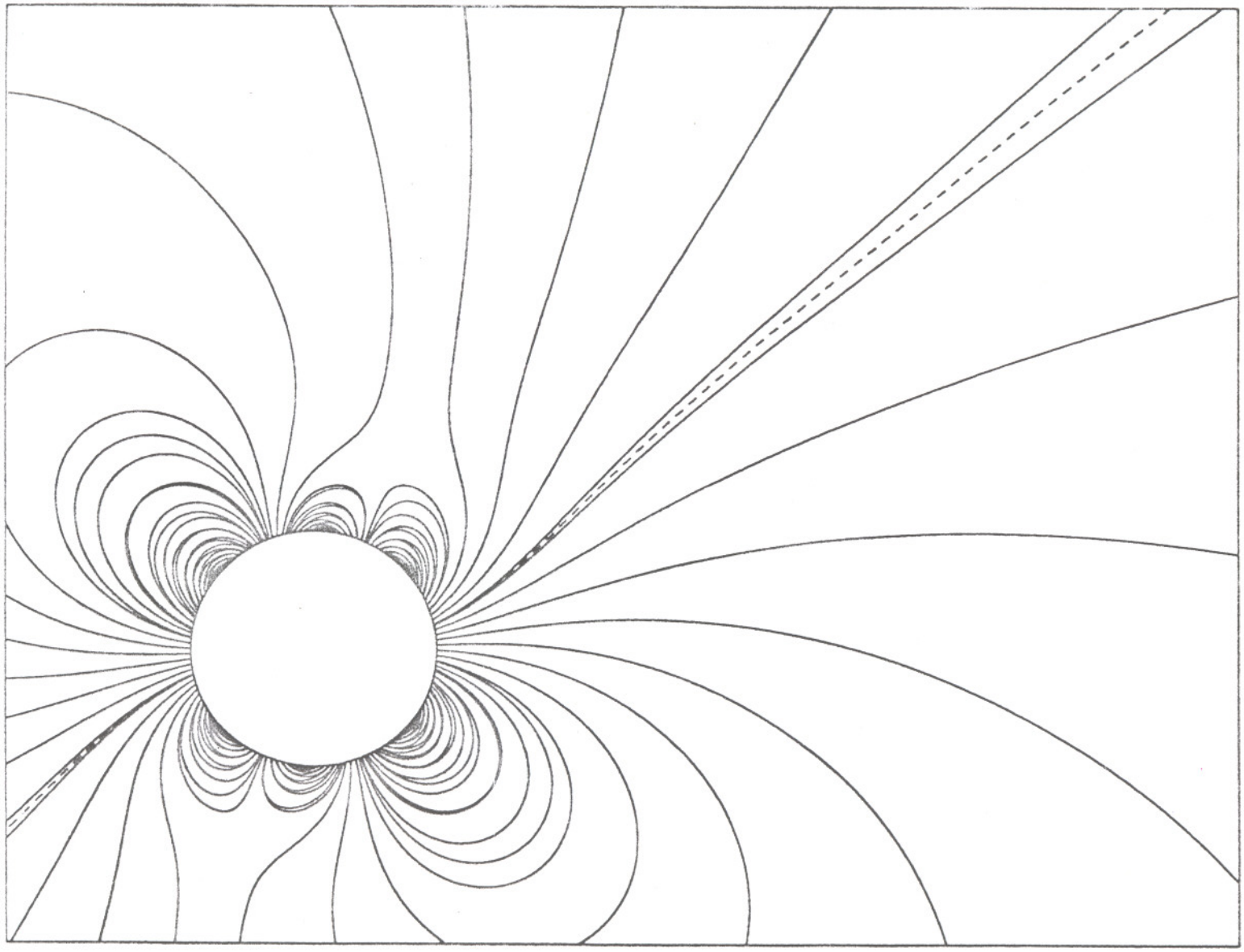
Bowshock of the msec-PSR B1957 + 20 moving at 10^2 (Km/s) for d = 0.73 Kpc, mapped in Hα. 1' ≃ 0.22 pc (d/0.73 Kpc).

BEFORE:



AFTER:

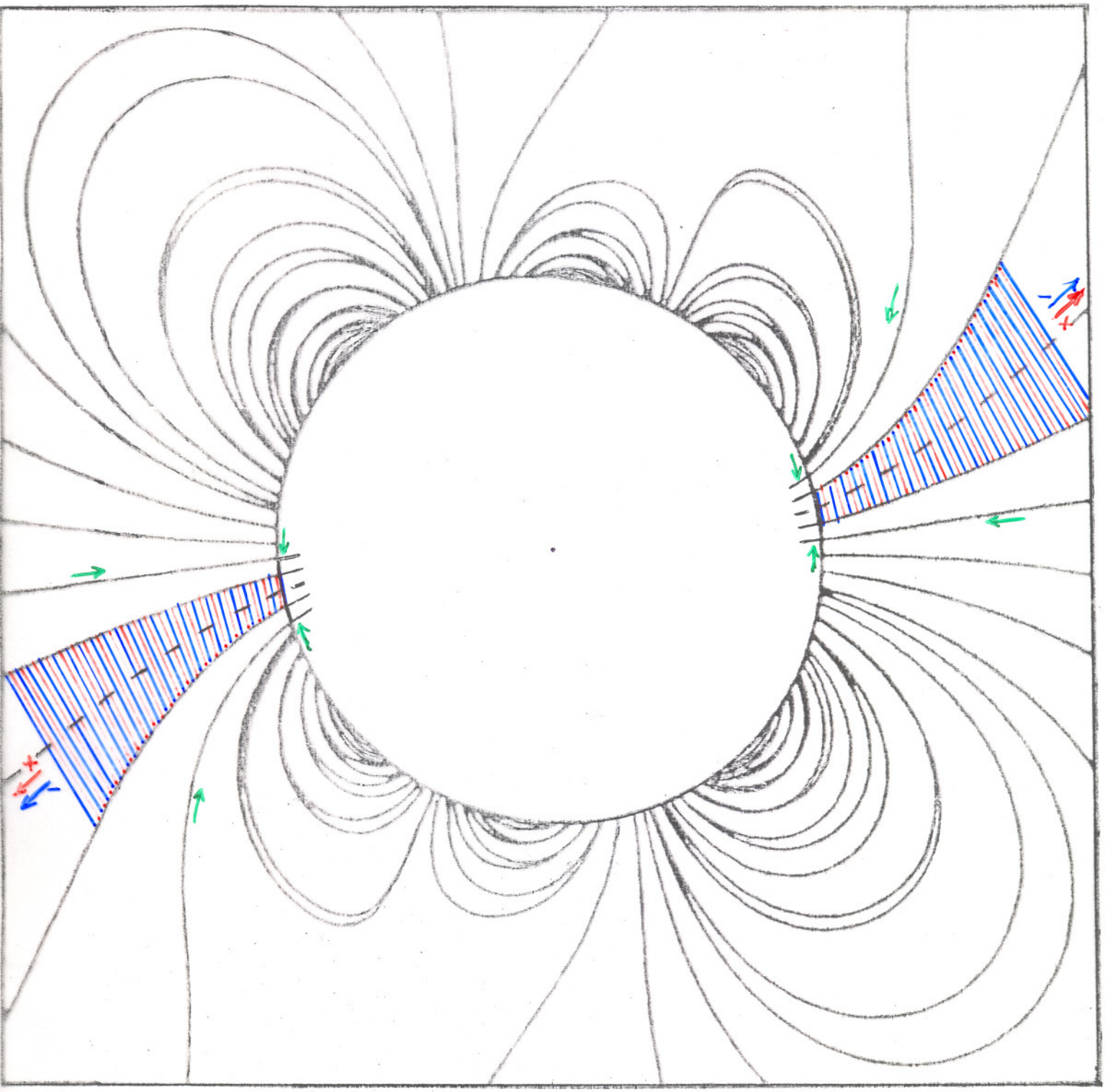




dipole ($i = 50°$) + 6 · octupole ($i = 90°$)

[Chang, May 1994]

→ forbidden $\left\{ \begin{array}{l} \text{by } \vec{E} \times \vec{B} \text{ forces, along } \vec{B} \\ \text{as Pedersen currents, } \perp \vec{B} \end{array} \right\}$



Dipole + 6 × (Octupole at 40°)

[H.-K. Chang, 1994]