MAGNETARS

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MAGNETARS have DIFFICULTIES

- *DEF.*: A Magnetar is a spinning, compact X-ray source – probably a neutron star – powered by a strong, decaying magnetic moment μ, (B_s $\Im$ 10^{15} G); [proposed by: R.C. Duncan & C. Thompson, 1992-96].
- *CANDIDATES*: AXPs, SGRs, Rotating Radio Transients, Stammerers.
- CLAIM: such sources do not exist; should be replaced by `throttled PSRs´.
- *DIFFICULTIES*:

(1) Such strong B_s would imply B_i $\aleph$ 10^{17} G in the core, at r $\aleph$ R/2 ; they are dynamically unstable.

(2) No plausible formation mode is known.

(3) The SGRs 1900+14 & 1806-20 had glitches with Δ(dP/dt)>0. (4)
Above candidates can be explained differently, in a consistent way.

PREFERRED DEFINITION

- *Def.*: A MAGNETAR is a strongly torqued neutron star (by a low-mass accretion disk), powered by accretion (& spin-down), with $B_s \aleph 10^{14}$ G, a `throttled pulsar´, usually old, but occasionally very young.
- *PROPERTIES*:

  (1) Its (spin) period P is usually $\in(5, 12)$s , as for the dying pulsars, (occasionally unknown).

  (2) Its spindown torque $T \approx r\_ \langle B_r B_\varphi \rangle$ tends to be several 10_ times stronger than the (unconfined) pulsar torque.

  (3) Its accretion power is $L_X \aleph 10^{36}$ erg/s.

  (4) It is often found inside of a Pulsar Nebula.

Are the Magnetars

a subset of all (ordinary)

Pulsars,

comprising the AXPs, the SGRs,
the `stammerers´ (= RRATs),

the CR-boosters, and

even all the GR-bursters ?

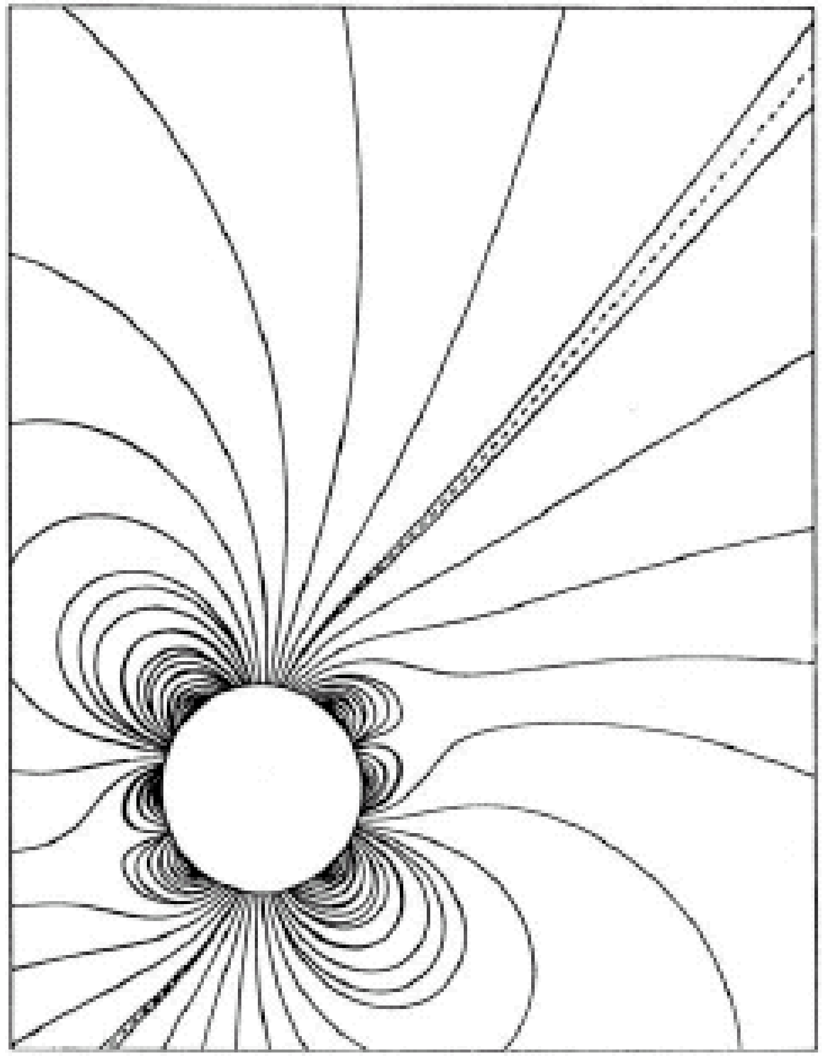


Fig. 2. Plausible pulsar magnetosphere, obtained by adding 6 times a normalized octupole to a dipole inclined by 40 deg, from Chang (1994).

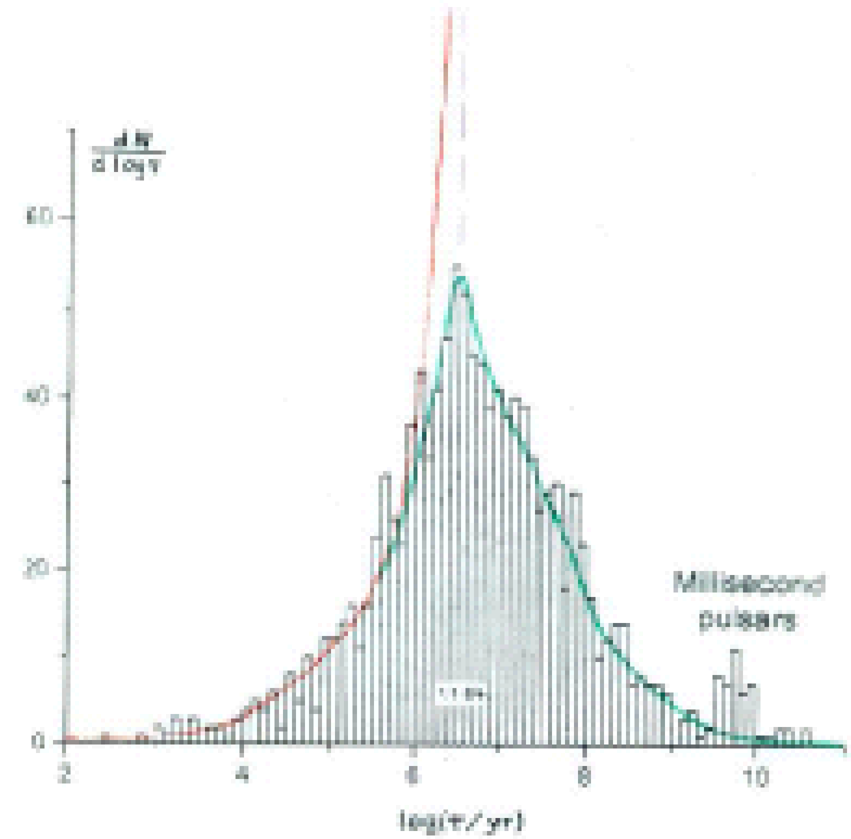


Fig. 1. N = 1194 pulsars plotted linearly w.r.t. their logarithmic spindown age, dN/dlogτ vs $\log(\tau/\mathrm{yr})$, $\tau := P/2\dot{P}$. For a stationary age distribution, the upper envelope would rise exponentially, as drawn in - both solid and broken - for two extreme interpretations of the noise. Clearly, there is an increasing deficit of detected pulsars for $\tau \geq 10^{6.4}$yr. The small bump of ms pulsars, of spindown ages between $10^{9.5}$yr and 10^{10}yr, may be due to those in globular clusters.

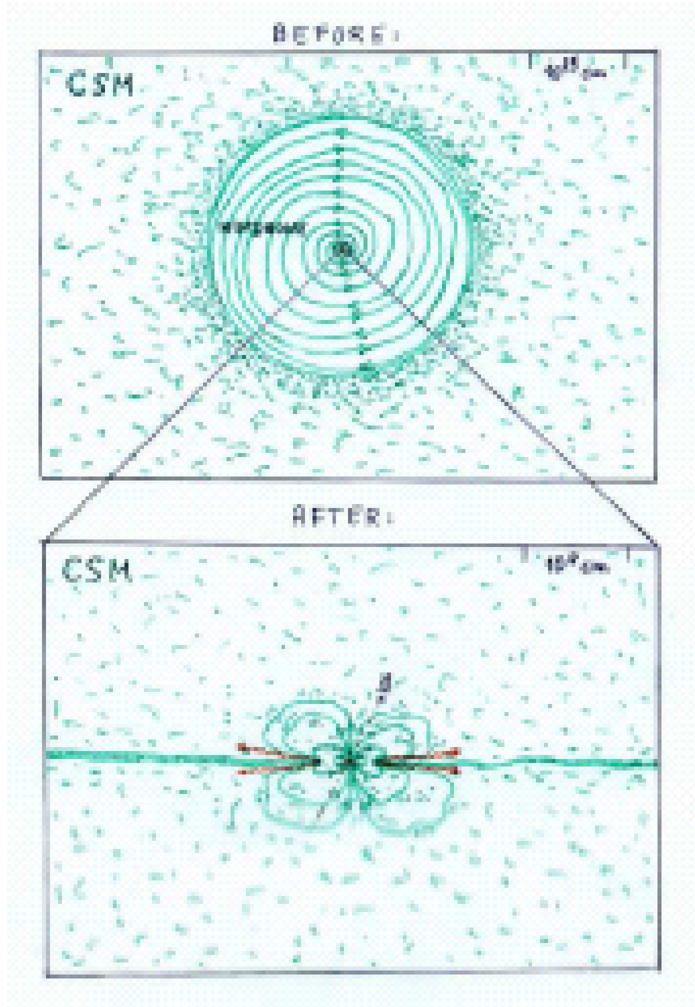
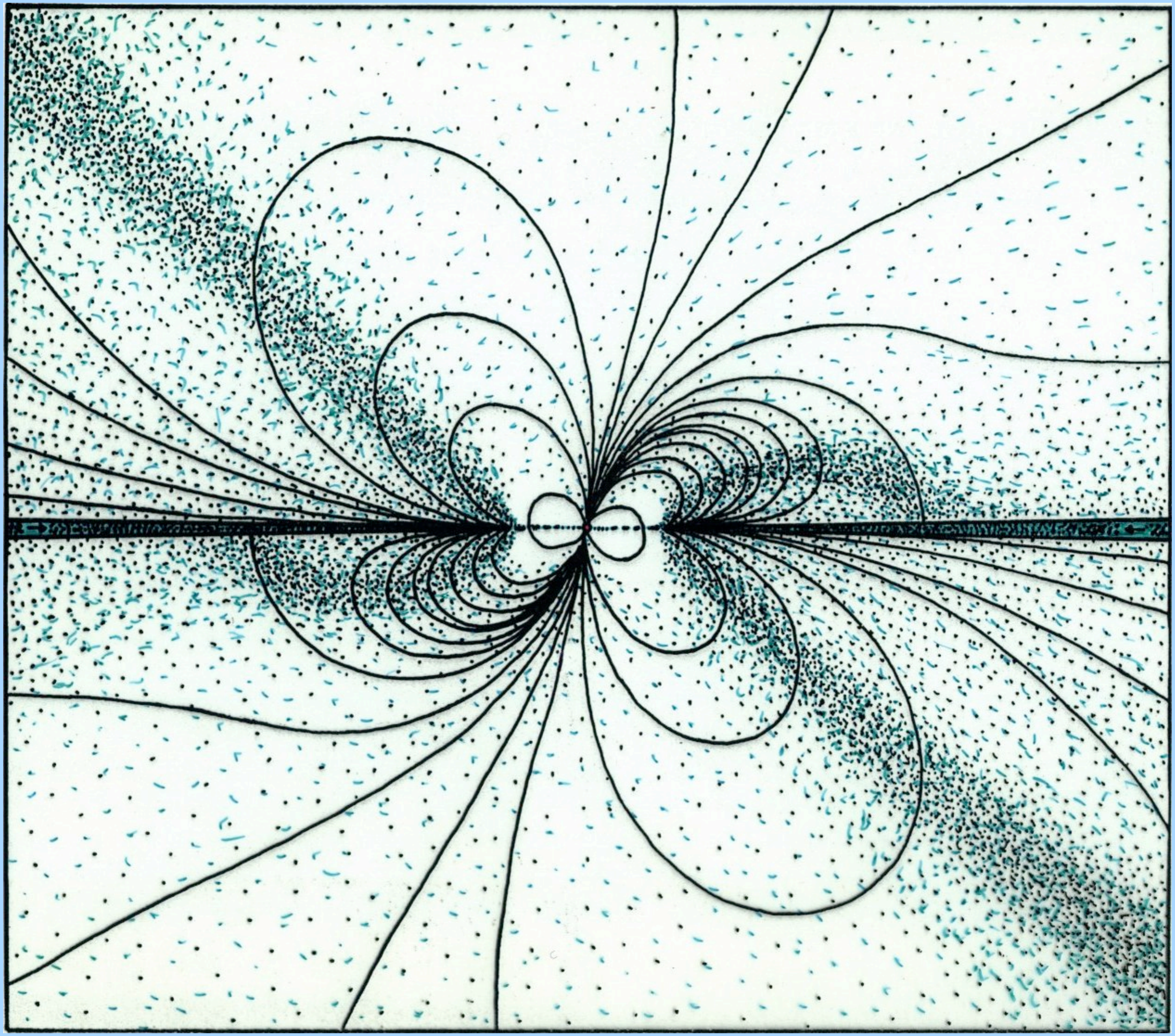
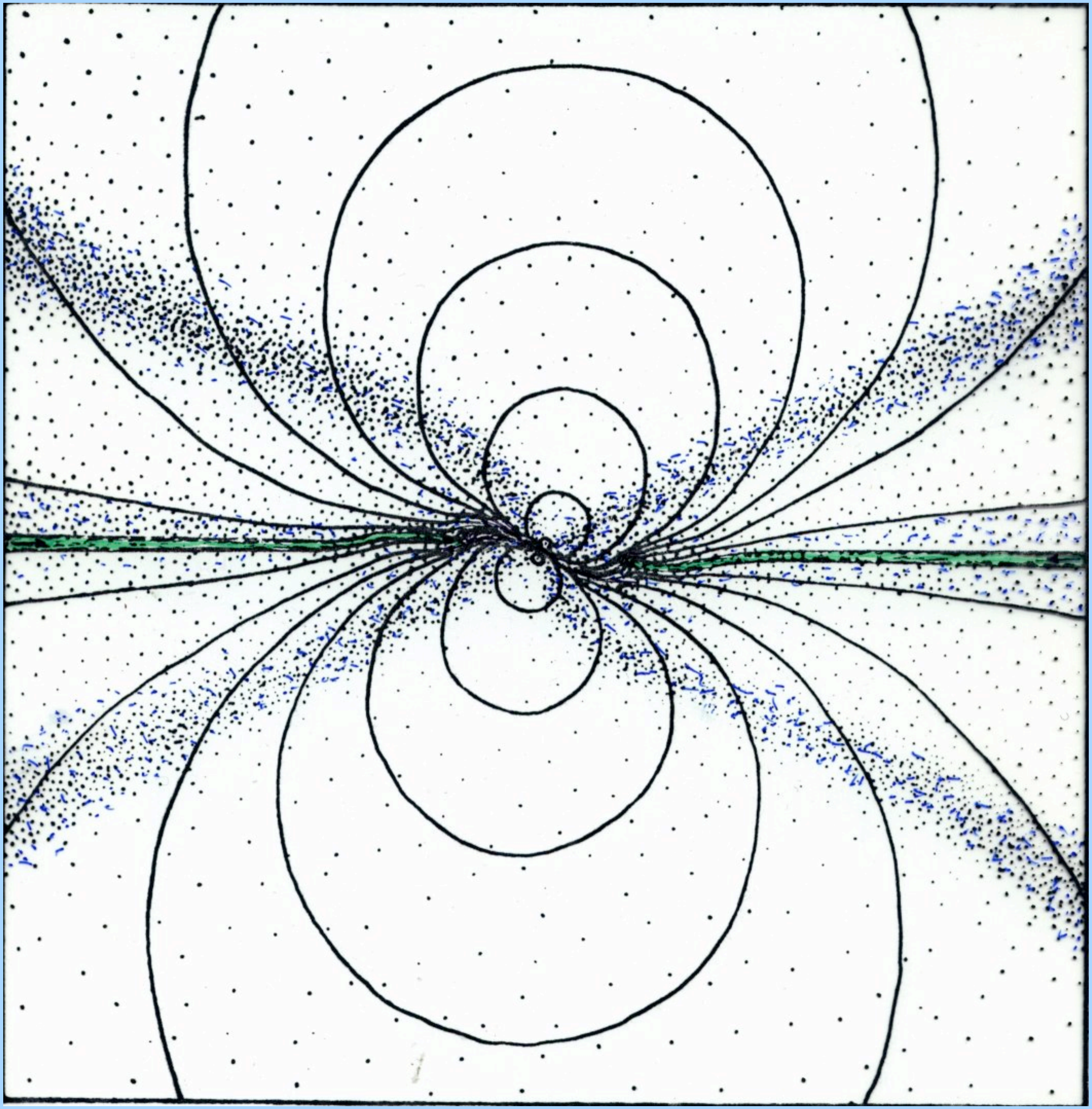


Fig. 3. Cartoon sketching a pulsar's suffocation, on two scales: once the heavy 'atmosphere' of its windzone quenches it, by free-falling down under angular-momentum conservation, it forms a low-mass accretion disk cutting deeply into its corotating magnetosphere, resembling a relativistic grindstone (at its inner edge). CR and impact emissions will be preferentially in the plane of the (inner) disk.





CONFIRMING EVIDENCE

Indeed, the new interpretation (of the magnetars) completes our understanding of the late stages of pulsars: Once their wind pressure $p_w \sim 1/P∃$ falls below circumstellar values, the wind-blown cavity – of radius some 10^{15} cm – collapses, and forms a low-mass accretion disk (M ℵ 10^{-6} $M_|$) around the dying PSR, confining ist magnetosphere, and strongly enhancing ist spindown ...

- The disk´s inner edge cuts into the PSR´s corotating magnetosphere, which acts like a ring of relativistic slingshots during their sawtooth-shaped torsional oscillations, generating cosmic rays. Occasionally, clumps from the disk´s inner edge accrete onto the n*´s surface, giving rise to GRBs. The nearest (and loudest) of them are seen as SGRs.
- Very young PSRs, like the Crab and the Vela, are seen to be likewise surrounded by circum-PSR low-mass CSM, giving rise to strong X-radiation, and (invisible) CRs. These few, young PSRs of high spin rate create (at least) the sparse, most powerful upper end of the CR spectrum.

A FEW FORMULAE

- Pulsar´s Spin Period for marginally stable cavity:

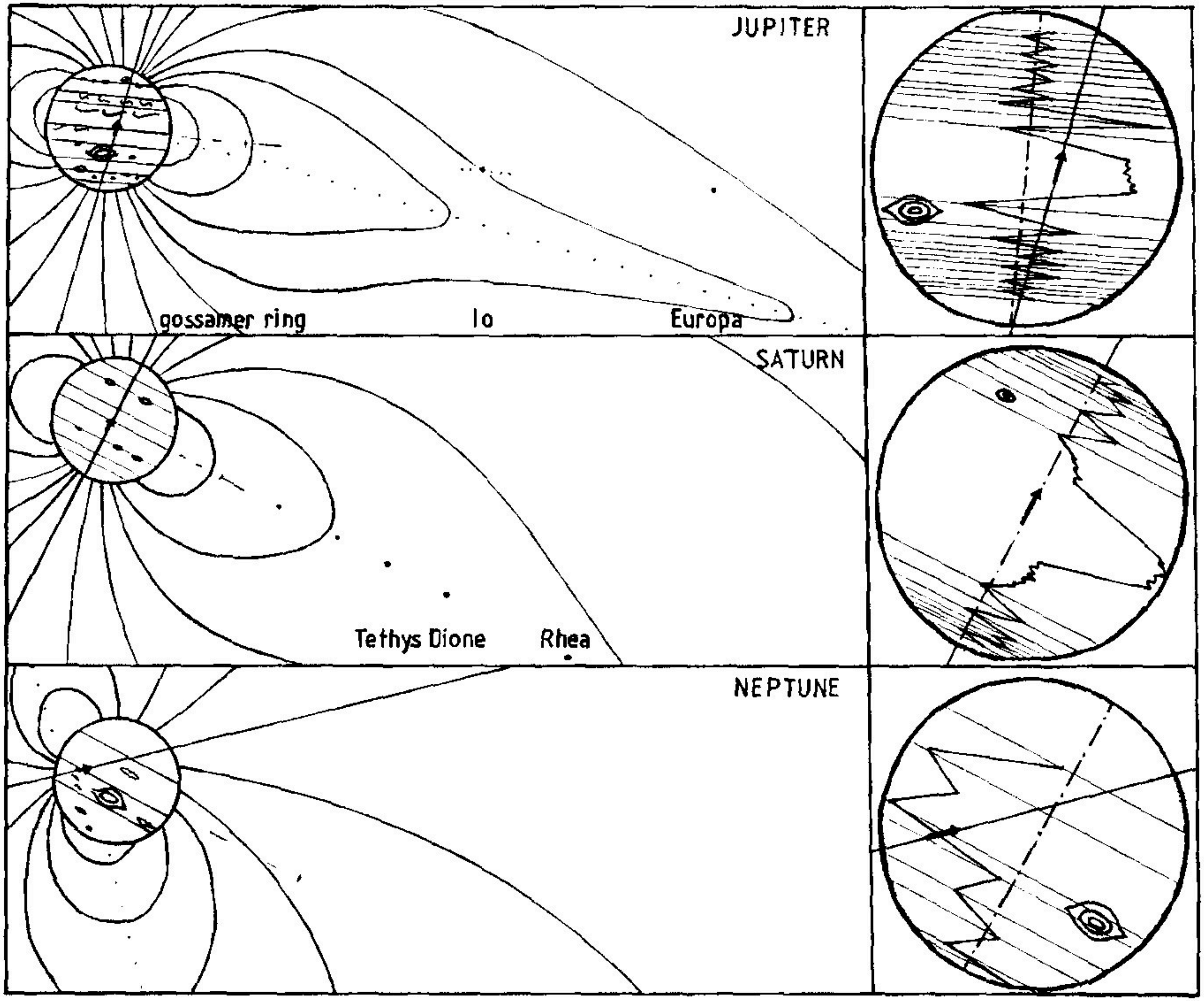
  $P = 8\text{ s}\, (\mu_{31}\, T_3 / \sqrt{p_{-12.3}})^{1/2}$.

- Minimal Cavity Radius:

  $r = G\, M\, m_p / 2\, k\, T = 10^{14.9}\text{ cm} / T_3$.

- A throttled pulsar‘s Spindown Time:

  $\tau = 10^{(4 \pm 1)}\text{ yr}$.


JUPITER
gossamer ring
Io
Europa
SATURN
Tethys Dione
Rhea
NEPTUNE