$-(t/\tau_v)]$. The constant τ_m' (proportional to $(GM/Rc^2)^{-(m+1/2)}$ (refs 9,10), where R is the neutron-star radius) is estimated to lie in the range 1.3×10^{-3} s ($m = 3$) to $3.4 \times 10^{+2}$ s ($m = 5$), by using the growth times calculated for the non-rotating models[11] and their angular-velocity dependence[12,13]. We expect that, at present, $\mathrm{d}^{n+1}F/\mathrm{d}t^{n+1} \approx (-2/\tau_v')\,\mathrm{d}^nF/\mathrm{d}t^n$ for $n \geqslant 1$, where the approximately constant effective damping rate is $1/\tau_v' = 1/\tau_v - 1/\tau_m$.

The expectation that $\tau_m \ll \tau_v$ and the fact that $\tau_m \ll 1$ year if the neutron star was born with its maximum uniform rotation rate leads to the following evolutionary scenario. The amplitude ΔR of all such modes built up quickly (on a timescale of the order of τ_m) until limited by nonlinear effects to a value $\lesssim R$. The star then spun down rapidly (with constant ΔR but increasing timescale τ_m) until $\tau_m > \tau_v$. At present, $T_0 \gg 0.5\,\mathrm{yr} > \tau_v'$. If τ_v' were larger, the slow-down rate would exceed the observed limit, unless $\tau_v \gtrsim 10^3((\Delta R)_{\max}/R)^2$ yr. If the present temperature of the neutron star is about 10^9 K, we estimate that the viscous timescale τ_v is of the order of 10^6 s if dominated by neutron–neutron scattering (in the absence of magnetic effects)[14–16].

In the phase through which the neutron star is presently evolving,

$$\left(\frac{F(t)}{F_m}-1\right)^{-2m} \approx \left(\frac{F(0)}{F_m}-1\right)^{-2m} + \left(\frac{mQ_m\tau_v'}{\tau_m'}\right)[1-\exp(-2t/\tau_v')] \qquad (2)$$

Here, Q_m is an approximate constant of the order of $((\Delta R)_{\max}/R)^2$. Although this evolution depends on both the gravitational-growth and the viscous-damping timescales, its rate is controlled mainly by the latter, as the former is somewhat greater at present. From equation (1) we note that if $\tau_m \approx 0.1$ yr now, the present limit on the slow-down time T_0 places an upper limit of ~ 0.01 on $\Delta R/R$. Should an evolution of the frequency similar to that predicted by equation (2) be observed, a good estimate of the value of τ_v, which is poorly known at present, could be derived.

All other competing sources of spin-down, such as the usual one due to electromagnetic torques, yield a slow-down time T_0 of at least 10^7 yr. This model-independent value (assuming a moment of inertia $I \approx 10^{45}$ g cm^2) follows from the limit of $\dot{E} \leqslant 3 \times 10^{38}$ erg s^{-1} on the total power emitted by the pulsar in the form of electromagnetic radiation or charged particles, obtained from the bolometric luminosity of the supernova. Accretion torques provide a source of spin-up. If the mass accretion rate is constrained by the Eddington limit (which happens to match the above limit on $\dot{E}$), the accretion timescale is then also at least 10^4 times greater than the observed limit on T_0.

Even such a high accretion rate limits the surface value, B, of the magnetic dipole field to no more than about 10^9 G. A stronger magnetic field (or a lower accretion rate at this field value) would lead to the expulsion of the accreting matter beyond the light cylinder. But for a free pulsar the same limits on $\dot{E}$ also give[1,17] $B < 10^9$ G. If the values of B and the accretion rate $\dot{M}$ are such that the Ghosh–Lamb radius is comparable to the light cylinder radius (2.4×10^6 cm) — for example, if $\dot{M}$ is near the Eddington value and $B \approx 10^9$ G — it is possible that the pulsar turns on and off intermittently. This could explain the lack of pulsations in later observations[1]. The optical emission could arise in the free pulsar phase or in the X-ray (accreting) pulsar phase. Finally, our rotational interpretation of F requires the mean density of the star to be at least five times that of nuclear matter.

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Radiation limits

SIR—If, as John Dunster dubiously argues[1], "latency" is to be regarded as a crucial factor in setting permissible radiation doses, then standards should be set to protect the youngest members of society, as they have the longest latency period and the maximum 'detriment'. Unfortunately, the youngest are also the most radio-sensitive. Thus the excess relative risk of all cancers except leukaemia for those survivors who were under 10 years old at the time of the atomic bombings is about eight times higher than it is for those who were 35 or over[2]. Furthermore, the doubling dose for leukaemia in children under 10 at the time of the bombings is only 80 mSv. Exposure *in utero* may be even more hazardous; data from obstetric radiography indicates a doubling dose for all childhood malignancies as low as 10 mSv[3,4].

The logic of such observations is severely to tighten public dose limits. The International Commission on Radiological Protection (ICRP) has recommended that lifetime exposure should not exceed 1 mSv per annum, but the UK legal limit is still 5 mSv. The National Radiological Protection Board has recommended 0.5 mSv per annum[5], but has since increased its estimate of cancer risk for the general population to 4.5 times the ICRP figure of 1 death per 10,000 per 10 mSv[6]. In the United States the public dose limit has been 0.25 mSv for the past 10 years. Dunster's call for a 'measured response', and ICRP's reluctance to revise its own system of dose limitations[7] are not supported by the scientific data. A legal limit of 0.2 mSv per annum is urgently needed.

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Red Sea salinity

SIR—Thunell *et al.*[1] estimate the palaeo-salinity of the Red Sea for three different sea-surface levels: 80 m, 120 m and 150 m below the present-day level, based on strait-dynamics considerations[2], and show that their results compare favourably with palaeo-salinity estimates based on δ^{18}O of foraminifera. But they fail to take into account the fact that below a certain sea level, there will be a change in the sill responsible for flow control.

The strait of Bab-el-Mandeb, connecting the Red Sea with the Gulf of Aden (insert in figure), is a long strait, in the dynamic sense[3], and contains two main sills (see figure); the Hanish sill, at about 13°40′ N, is shallow and wide, whereas the Dumeira sill, at about 12°50′ N, is deeper but narrower. From strait-dynamics calculations[2], taking width and depth each with its prescribed weight, it is readily shown that at the present-day sea level, the Dumeira sill dominates the flow, and the Hanish sill has only a secondary effect on flow control.

Thunell *et al.* do not take into account that, with a sea-level drop of 70 m or more, the Hanish sill would take over the