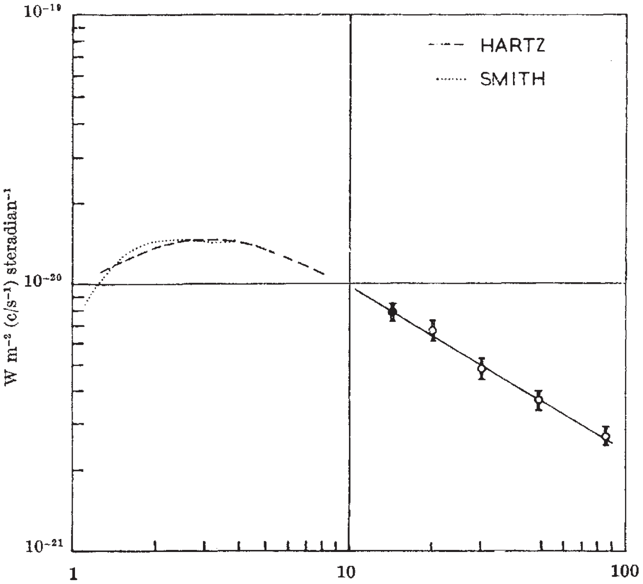

Fig. 2. Brightness-frequency relation. Scaled aerial results above 10 Mc/s, satellite results below 10 Mc/s

have differing spectra. The separation will be discussed by us elsewhere.

We are now making a new series of observations with scaled aerials of medium resolution.

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ASTROPHYSICS

Pulsation Periods of General Relativistic Objects

THE pulsation period of the lowest radial mode for a spherical homogeneous object in Newtonian theory is[1] (if Γ_1 = const):

$$\tau = 2\pi[4\pi G\rho(\Gamma_1 - 4/3)]^{-1/2}$$

and if $\Gamma_1 - 4/3 > 0$, the period may vary over a wide range depending on the density.

However, a spherically symmetric homogeneous object in the post-Newtonian approximation has a period of[2]:

$$\tau = 2\pi c\left\{4\pi G\varepsilon(\Gamma_1 - 4/3)\left[1 - (GM/c^2R)\left(\frac{10}{7}\,\Gamma_1 - 1\right)\right]\right\}^{-1/2}$$

where ε is the total energy density. From this equation it is easily seen that there will be a minimum period even if $\Gamma_1 - 4/3$ is always positive and finite. Substituting:

$$\varepsilon = 3Mc^2/4\pi R^3$$

we obtain:

$$\tau = 2\pi\left\{GMR^{-3}(3\Gamma_1 - 4)\left[1 - (GM/c^2R)\left(\frac{10}{7}\,\Gamma_1 - 1\right)\right]\right\}^{-1/2}$$

A very massive star (superstar) has a Γ_1 which is a function of mass and is approximately 4/3. The quantity $\Gamma_1 - 4/3 = \alpha(M/M_\odot)^{-1/2}$ (refs. 3 and 4). The minimum period will therefore occur at a radius of:

$$R = 76 \times GM/[63(\Gamma_1 - 4/3)c^2]$$

and:

$$\tau_{\min} = (304 \times \pi GM/63c^3)(76/189)^{1/2}(\Gamma_1 - 4/3)^{-2}$$
$$= 4{\cdot}73 \times 10^{-5}\alpha^{-2}(M/M_\odot)^2 \text{ sec}$$

or:

$$\tau_{\min} = 1{\cdot}50 \times 10^{-12}\alpha^{-2}(M/M_\odot)^2 \text{ yr}$$

A superstar of $10^6\ M_\odot$ would therefore have a period of (for $\alpha = 1{\cdot}4$) 0·77 yr. If quasi-stellar sources are very large massive objects with fluctuations of the order of years, then one would not expect them to be much larger than $10^6\ M_\odot$ because of the quadratic mass dependence of the periods. W. A. Fowler has recently pointed out that rotation may enable one to have smaller periods and therefore smaller radii[5].

This general relativistic effect of a minimum period also manifests itself in neutron stars[2] and white dwarfs, although in these cases the models are not homogeneous and Γ_1 is not constant.

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Angular Momenta of Eclipsing Binaries and the Fission Theory of their Origin

IN a new development of the fission theory of the origin of close binary stars[1,2], I showed that rotational instability would occur during the pre-main sequence contraction of rotating stars with no internal magnetic field. The theory predicted the observed mass range for contact binaries of *W*-Ursae Majoris type with satisfactory accuracy, and also gave the observed variation of angular momentum with mass for these systems. I now wish to show that the theory also predicts the observed relation between angular momentum and mass for all the close binary systems.

The rotational instability which gave rise to the formation of binary systems was due to the different behaviour of convective and radiative regions of stars. When the star is fully convective, as it is during early stages of contraction[3], it rotates uniformly, and as the angular velocity increases the star spins of mass at the equator, and the effect of rotation is small over the bulk of the star. When the star begins to develop a radiative core, the rotation is no longer uniform as each element of the radiative core contracts, conserving its angular momentum. The parameter that measures the effect of rotation is:

$$\alpha = \frac{\Omega^2}{2\pi G\rho_c} \qquad (1)$$

where Ω is the angular velocity and ρ_c the density at the centre of the star. When the star was fully convective, then with uniform rotation and centrifugal force balancing gravity at the surface, $\alpha = 0{\cdot}04$ (ref. 4). With the development of the radiative core α varies like $\rho_c^{1/3}$ and so it will reach the critical value for instability, 0·187 (ref. 5), when ρ_c has increased by a factor 100.

The increase in ρ_c is due to two effects : the changing degree in central condensation due to the transition from convective energy transport, $\rho_c/\bar{\rho} = 6$, to radiative energy transport, $\rho_c/\bar{\rho} \simeq 24$ for massive stars and 54 for small stars, and the increase in the mean density $\bar{\rho}$ due to the decrease in radius. As the readjustment in internal