$$\Sigma\varepsilon^2 = \text{constant} \tag{2}$$

Equation (2) is the general fatigue law for variable $\varepsilon$. In the special case where $\varepsilon$ is constant, this general law reduces to equation (1), with $f(\varepsilon_0) = \varepsilon_0/\sqrt{2}$ in good accord with experiment.

Equation (2) is also algebraically equivalent to both the following:

$$\varepsilon_{\text{r.m.s.}} \sqrt{N} = \varepsilon_0/\sqrt{2} \tag{3}$$

$$\frac{N_1}{N_{f1}} + \frac{N_2}{N_{f2}} + \frac{N_3}{N_{f3}} + \text{etc.} = 1 \tag{4}$$

where $\varepsilon_{\text{r.m.s.}}$ is the root mean square (r.m.s.) strain; $N_{f1}$ is the number of cycles of strain-range $\varepsilon_1$ which would cause failure by themselves; $N_1$ is the actual number of cycles of strain-range $\varepsilon_1$.

Table 1 exemplifies data for 20 Cr—25Ni—1Nb stainless steel which confirm the general fatigue law (equation (2) ). The tests were done in an *Instron* in push-pull plastic fatigue at 650° C. In Table 1, $N_1$, etc., is the number of cycles having plastic strain range $\varepsilon_1$, etc., while the calculated value for the total number of cycles derives from a least-squares analysis of these and other similar data, using equation (2).

Table 1. Data which confirm the General Fatigue Law

| Test No. | $N_1$ | $\varepsilon_1$ | $N_2$ | $\varepsilon_2$ | $N_3$ | $\varepsilon_3$ | $\sum_3^1 N_x$ Calculated | $\sum_3^1 N_x$ Actual | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0·5 | 0·906 | 0 | 0 | 0 | 0 | 0·37 | 0·50 | Tensile test |
| 2 | 3 | 0·298 | 0 | 0 | 0 | 0 | 3·40 | 3 | Constant $\varepsilon$ |
| 3 | 48 | 0·081 | 0 | 0 | 0 | 0 | 45 | 48 | Constant $\varepsilon$ |
| 4 | 63 | 0·069 | 0 | 0 | 0 | 0 | 63 | 63 | Constant $\varepsilon$ |
| 5 | 43 | 0·062 | 5 | 0·067 | 5 | 0·137 | 55 | 53 | Variable $\varepsilon$ |
| 6 | 100 | 0·029 | 11 | 0·068 | 10 | 0·137 | 110 | 121 | Variable $\varepsilon$ |
| 7 | 124 | 0·030 | — | — | 8 | 0·136 | 127 | 132 | Variable $\varepsilon$ |

Equation (1) is known as 'Coffin's Law' and equation (4) is Miner's hypothesis. Both are now seen to be derivatives of the general fatigue law (equation (2) ), a law which is founded on a simple theory and supported by data of the type exemplified in Table 1.

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## COSMOLOGY

### Cosmic Explosions

Recognition of the nature of radio and 'star' galaxies has prompted many theoretical interpretations during recent years. The vast amount of energy emitted is difficult to account for on present astrophysical theory, and has led to several cosmological explanations. In particular, McCrea[1] envisages a form of the steady-state universe in which matter is created in the nuclei of galaxies, where the density of matter is already high, as a property of existing matter. Thomas[2] suggests that violent metric adjustments (explosions) must occur to prevent the infinite metric discontinuity at the Schwarzschild radius of a collapsing sphere. Out of these 'surface explosions' matter is created. How the sphere collapses to this state in a finite time (to an external observer) is unspecified, and the possibility has been seriously questioned[3].

I propose that: (1) matter is created preferentially where the density of matter is lowest, for the very reason that universal expansion causes the low density; (2) quasi-stellar radio sources, or 'quasars', are the manifestation of this creation. Since the observed red-shift of quasars is assumed to be cosmological, I further postulate that matter is created already sharing the universal expansion. In this picture, then, matter originates in galaxy-sized 'ylem' of evolutionary cosmology, occurring sporadically in the empty reaches of space between galaxy clusters, but maintains on the average the amount required by steady-state theory. Hence the universe is in a quasi-steady-state.

The consequences of my proposal may be investigated in terms of astronomical data already available. The creation rate of matter from quasars will be $NM/\tau^{-1} = 10^3 \times 10^9 \times 10^{-1} = 10^{11}\ M_\odot$/year, where $N$ is the total number of quasars in the visible universe[4], $M$ is the total mass of a typical quasar in units of the Sun's mass[5], and $\tau$ is the time of formation of a quasar in years[6]. This rate is the same as the required mean rate of creation of observed matter (assumed to be predominantly in galaxies) during the Hubble age of the universe.

Observations[6] suggest that much of the mass in quasars may be formed very quickly, if not instantaneously, although continuing creation over a period as long as a million years[5] is not forbidden. Nuclear statistical equilibrium in the expanding protoquasar will produce the required[7] cosmic primordial abundances of the elements. Difficulties with the theory of condensation of galaxies from a uniform intergalactic medium can be overcome, and, in fact, some quasars themselves may evolve directly into normal radio galaxies[4]. Clusters of radio galaxies will result if quasars are formed in groups; presently known quasars (first of a group?) appear outside of galaxy clusters[8], in accordance with postulate (1). Thus galactic masses may be closely related to quasar masses.

My proposal relates the quasars intimately to cosmology. It tries to answer the cosmogonic question by providing for the spontaneous creation of energy-mass, primordial cosmic rays, and, possibly, angular momentum.

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## METALLURGY

### An Integrated Theory of Stress Corrosion

The electrochemical-mechanical theory now favoured states that the dislocation substructure is the controlling factor in the process of stress-corrosion cracking of austenitic stainless alloys[1–4]. If the dislocations become piled up on slip planes due to a low stacking fault energy, a susceptible alloy results. On the other hand, if a cellular arrangement is obtained as a result of a high stacking fault energy, the alloy is not susceptible to failure. The emergence of the dislocation pile-ups at the surface produces the chemically reactive sites for crack initiation. To explain the apparently anomalous stress-corrosion resistance of 'Incoloy 800' (high stacking fault energy and a planar dislocation arrangement) and nichrome (planar arrangement) the concept of short-range order was intro-