LETTERS TO THE EDITOR

A PLANE SYMMETRIC UNIVERSE FILLED WITH STIFF MATTER

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RECENTLY considerable interest has been created in the study of equation of state[1] $\rho = p$ for the matter content of the universe in its early stages. In this note, considering a special case of the perfect fluid distribution discussed for the Marder metric by Singh and Abdussattar[2] with metric potentials $A = B$ and equation of state $\rho = p$ for stiff matter, a cosmological model is obtained as

$$ds^2 = (1 + at)^{2\beta}\{dt^2 - dx^2 - dy^2\} - (1 + at)^{2-2\beta}\, dz^2 \qquad (1)$$

where a is an arbitrary constant and β is a positive number less than 2. The distribution in the model is given by

$$8\pi p = 8\pi\rho = \frac{a^2 \beta (2 - \beta)}{(1 + at)^2 (\beta + 1)}. \qquad (2)$$

The coordinate system turns out to be comoving with $v_4 = (1 + at)^{\beta}$ The flow vector v_i satisfies the equations of the geodesics $v^i{}_{;j}v^j = 0$ and hence the lines of flow are geodesics. The universe described above is irrotational but not shear free. The surviving components of the shear tensor σ_{ij} and the scalar of expansion θ[3] for the model are given by

$$\sigma_{11} = \sigma_{22} = \frac{a(1 - 2\beta)}{3(1 + at)^{1-\beta}},$$

$$\sigma_{33} = \frac{2a(2\beta - 1)}{3(1 + at)^{3\beta-1}}, \qquad (3)$$

and $$\theta = \frac{a(\beta + 1)}{(1 + at)^{\beta+1}}. \qquad (4)$$

If we take a as a positive constant, θ is always positive. Therefore the universe is expanding with time. From (2) and (4) we see that when t tends to zero

$$\rho\,(= p) \to \frac{a^2 \beta (2 - \beta)}{8\pi} \quad \text{and} \quad \theta \to a(\beta + 1)$$

and when t tends to infinity $\rho\,(= p)$ and θ tend to zero. That is, $\rho\,(= p)$ and θ are decreasing functions of time and the rate of expansion of the universe is large in the beginning. From the physical components of the non-vanishing Riemann curvature tensor for the metric (1) we find that the model is asymptotically flat. The model admits a four-parameter group of motions. Petrov-Pirani classification of the model reveals that it is of Petrov type I-D. If we take $\beta = 0$ the space time is flat. For $\beta = \frac{1}{2}$ we get the conformally flat metric with

$$8\pi p = 8\pi\rho = \frac{3a^2}{4(1 + at)^3}$$

and for $\beta = 2$ we have $R_{ij} = 0$, $R_{hijk} \neq 0$. By a suitable transformation the line-element in geodesic form can be written as

$$ds^2 = dT^2 - T^{2\beta/(\beta+1)}(dX^2 + dY^2) - T^{(2-2\beta)/(\beta+1)}\, dz^2. \qquad (5)$$

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1. Wesson, P. S., *J. Math. Phys.*, 1978, **19** (11), 2283.
2. Singh, K. P. and Abdussattar, *J. Phys. A.: Math. Nucl. Gen.*, 1973, **6**, 1090.
3. Ellis, G. F. R., *General Relativity and Cosmology*, edited by R. K. Sachs, Academic Press, New York and London, 1971, p. 110.

BACK SCATTERED *m*-LINES

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THE observation of back-scattered
use in locating the mode angles in thin film optical wave guides are presented. Observation is made on solution deposited polystyrene thin films using a prism coupler.

Thin films of polystyrene are formed on ultrasonically cleaned glass slides (index = 1·513) by spin-coating. Films are cured at about 120° C to remove stress birefringence[1]. The thickness of the films thus formed were such that these were capable of supporting only TE_0 and TM_0 modes. The film is clamped with a symmetric EDF glass prism (index = 1·698) to couple the light in and out of the film to observe *m*-lines[2]. A patch is observed at the centre portion of the prism base. This portion is the coupling region,