LETTERS TO THE EDITOR

A PLANE-SYMMETRIC UNIVERSE FILLED WITH PERFECT FLUID

The geometry of the universe is described by the metric,

$$ds^2 = -\left\{\alpha T - \frac{4}{T}\right\}^2 dx^2 - T^2(dy^2 + dz^2) + dT^2, \quad (1)$$

where α is a positive arbitrary constant. From the field equations of the relativistic gravitation for a perfect fluid distribution,

$$R_j^{\,i} - \tfrac{1}{2} R g_j^{\,i} + \Lambda g_j^{\,i} = -8\pi \{(p+\epsilon) V^i V_j - p g_j^{\,i}\}, \quad (2)$$

the pressure p and the density ϵ of the distribution in the model are given by,

$$8\pi p = \Lambda - \frac{1}{T^2}, \quad (3)$$

$$8\pi\epsilon = \frac{3}{T^2} + \frac{16}{T^2(\alpha T^2 - 4)} - \Lambda. \quad (4)$$

The physical conditions $\epsilon > 3p > 0$ demand that the time T should be restricted by the inequality,

$$\frac{1}{T^2} < \Lambda < \frac{3}{2T^2} + \frac{4}{T^2(\alpha T^2 - 4)}. \quad (5)$$

The coordinate system turns out to be comoving with $V_4 = 1$. 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. From the study of the geodesic equations we conclude that a particle initially at rest in the model remains permanently at rest. The universe described above is irrotational but not shear free. The non-vanishing components of the shear tensor, $\sigma_j^{\,i}$, and the scalar of dilation, θ, for the model are given by,

$$\sigma_{11} = \left\{\frac{(6\alpha T^2 + 8)(\alpha T^2 - 4)}{3T^3}\right\},$$

$$\sigma_{22} = \sigma_{33} = \left\{\frac{2T(3\alpha T^2 - 8)}{3(\alpha T^2 - 4)}\right\},$$

$$\theta = \left\{\frac{(3\alpha T^2 - 4)}{T(\alpha T^2 - 4)}\right\}.$$

The model admits a four parameter group of motions. The non-vanishing components of the Weyl conformal curvature tensor, C_{hijk}, for the model are given by,

$$C_{12}^{\;12} = C_{13}^{\;13} = C_{24}^{\;24} = C_{34}^{\;34} = -\tfrac{1}{2} C_{14}^{\;14} = -\tfrac{1}{2} C_{23}^{\;23} = \left\{\frac{-8}{3T^2(\alpha T^2 - 4)}\right\},$$

Petrov-Pirani classification of the model reveals that it is of Petrov type I D.

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SIMULTANEOUS SPECTROGRAPHIC DETERMINATION OF VOLATILE AND REFRACTORY IMPURITIES IN TANTALUM OXIDE USING A D.C. ARC EXCITATION

Simultaneous determination of volatile and refractory impurities in tantalum oxide is generally done by a.c. arc method[1-3]. Since this source of excitation is not commonly available as compared to d.c. arc in smaller laboratories, a method for simultaneous determination of impurities using the conventional d.c. arc was developed. Methods for determination of either volatile[4,5] or refractory impurities[6] are available but no method is reported for simultaneous determination using a d.c. arc. Our experiments showed that using proper weight ratio of ZnO and graphite as buffer all impurities could be simultaneously determined. The method developed now estimates 12 impurity elements which include refractory elements like Nb and Zr and volatile elements like Pb and Sn in tantalum oxide.

Standards are prepared synthetically by dry-mixing the spec-pure grade oxides with tantalum oxide. All compounds used are supplied by Johnson Matthey and Co. 30 mg of a mixture of sample (standard), ZnO and graphite (1 : 1 : 1) is loaded in the crater of a ¼″ U.C.C. electrode. The sample as anode is excited at 15 amperes in a d.c. arc. The spectrum is photographed in the region 2300 Å to 3500 Å on Ilford N. 30 emulsion employing a JACO 3·4 metre grating spectrograph, in the first order of a 1200 grooves/mm grating blazed at 3300 Å.

Different weight ratios of sample, ZnO and graphite tried during experiments are 3 : 1 : 2, 2 : 1 : 1, 1 : 1 : 1 and 1 : 0 : 1. The ratio of 1 : 1 : 1 is found to give best overall sensitivity and uniform volatilisation of impurities.

A weak line of Ta at 2974·6 Å is selected as an internal standard. Other analytical details are given in Table I.

It is also found that tantalum oxide used for preparation of standards is impure and contains following elements: Fe—5 ppm, V—10 ppm, Al—15 ppm, Mo—20 ppm, Nb and Zr—30 ppm and Si—40 ppm. These elements are determined by the method of trial additions. The working curves