

12th

INTERNATIONAL

CONFERENCE

ON GENERAL RELATIVITY

AND GRAVITATION

*Under the auspices of the International Society on
General Relativity and Gravitation*

Cosponsored by
the University of Colorado at Boulder and
the National Institute of Standards and Technology

Boulder, Colorado

July 2-8, 1989

Abstracts of Contributed Papers

Biblioteka IFT UW



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A UNIFIED REPRESENTATION FOR THE SHEARFREE NORMAL MODELS

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Shearfree normal models are perfect fluid solutions of the Einstein's equations in which rotation and shear vanish while expansion is different from zero. All shear- and rotation-free perfect fluid solutions were found by Barnes [1]. These with nonzero expansion contain the FLRW models in the limiting case when spatial gradients of pressure vanish. Hence, they are capable of describing (exactly) the evolution of a certain class of inhomogeneities in the universe. There are 3 classes of them, each with a different symmetry group: the spherically symmetric models, the plane symmetric models and the hyperbolically symmetric models. As presented by Barnes, the 3 classes are disjoint and require separate formulae. However, it is possible to represent the whole collection in the form of a single 2-parameter family of spacetimes. The metric of the family is:

$$ds^2 = D^2 dt^2 - (R^2/V^2)(dx^2 + dy^2 + dz^2) \quad (1)$$

where $D = F(R/V)(V/R)_t$, $F(t)$ and $R(t)$ are arbitrary functions,

$$V(t, x, y, z) = (z + b)S(t, Z), \quad (2)$$

where b is an arbitrary constant, and $S(t, Z)$ is determined by the equation:

$$R(t)S_{,ZZ}/S^2 = f(Z), \quad (3)$$

where $f(Z)$ is an arbitrary function and the variable Z is defined by:

$$Z = \frac{1}{2}(a - x^2 - y^2 - z^2)/(z + b), \quad (4)$$

a being another arbitrary constant.

The equation (3) is of the same form as the one introduced by Kustaanheimo and Qvist [2]. In general, its solutions cannot be expressed in terms of elementary functions, and a completely general solution is unknown, but the body of literature dealing with particular subclasses of solutions is very large (see Refs. 3-5 for partial reviews).

When $a < b^2$, the symmetry group of the model is isomorphic to $O(3)$, when $a = b^2$ it is isomorphic to the symmetry group of the Euclidean plane, when $a > b^2$, it is isomorphic to $O(2, 1)$ —the symmetry group of a surface with negative constant curvature. The coordinate transformations that relate (3) to the 3 classes of Barnes involve subcases of conformal symmetries of the 3-dimensional Euclidean plane and are rather complicated (see Ref. 4 for details).

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