Gravitational Fields with Groups of Motions on Two-dimensional Transitivity Hypersurfaces in a Model with Matter and a Magnetic Field

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Abstract. For gravitational fields with metrics which admit of groups of motions multiply – transitive on 2-dimensional space-like invariant varieties, the exact solutions of the Einstein gravitational equations are given for the case when the sources of the gravitational field are dust-like matter and a magnetic field. A magnetic field is orientated along a direction orthogonal to transitivity hypersurface. The solutions contain arbitrary functions. In the case of transitivity hypersurface of positive curvature and in the absence of a magnetic field, the solution is reduced to the Tolman spherically symmetric solution for dust-like matter. The conditions are studied under which the solutions with a magnetic field become asymptotically isotropic and approach the flat and the open Friedmann models. The case of transitivity hypersurfaces with signature $(+ -)$ is also considered.

1. Introduction

The paper deals with exact solutions of Einstein equations in General Relativity for metrics which admit of multiply transitive groups of motions on 2-dimensional transitivity hypersurfaces V_2. Exact solutions are given for the case when the sources of gravitational field are dust (incoherent matter) and a magnetic field, the direction of which is orthogonal to V_2. These solutions contain arbitrary functions. The cases considered are those in which the signature of V_2 is $(+ +)$ and $(+ -)$ [1, 2].

In the case of space-like V_2 with positive curvature and in the absence of a magnetic field these solutions are reduced to well known Tolman-Bondi solutions for spherically symmetric gravitational fields [3, 4].

A study of gravitational fields, the sources of which are matter and a magnetic field, is important in the theory of anisotropic cosmological models with a primordial magnetic field [5–10] and also is of interest for the problem of gravitational collapse in a magnetic field. Considered solutions include a homogeneous anisotropic model with euclidian co-moving space and also contain a class of inhomogeneous solutions which asymptotically become isotropic and approach the Friedmann solutions in the flat and in the open models.