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A Class of Stationary Solutions of the Einstein-Maxwell Equations

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Abstract. The class depends on one harmonic function and two additional arbitrary constants. It refers to sources with spin and electric or magnetic charge, and includes some space-times which are flat at spatial infinity. However, it does not include a solution for a spinning particle with monopole charge and mass.

§ 1. Introduction

Among the known electrostatic solutions of Einstein-Maxwell theory are those of Papapetrou-Majumdar (PM) [1, 2] and those of Weyl [3]. Members of the PM class need have no spatial symmetry but every source is such that, in relativistic units,

$$m = |e|\,, \tag{1.1}$$

m and e being the mass and charge. Weyl's solutions have axial symmetry but the sources are less specialised and satisfy

$$m = ke\,, \tag{1.2}$$

k being a constant, the same for all. Thus the two classes are different, but have some common members.

Recently the PM solution has been generalised to what are called PIW solutions [4, 5]. These are stationary, need have no spatial symmetry, and arise from sources satisfying

$$m = |e|, \quad \boldsymbol{h} = \pm\boldsymbol{\mu}\,, \tag{1.3}$$

$\boldsymbol{h}, \boldsymbol{\mu}$ being angular momentum and magnetic moment. It is a natural step to seek that class of axially symmetric solutions which is related to the PIW class in a way similar to that in which the Weyl class is related to the PM class. The solutions would depend on two harmonic functions (like PIW) and would have

$$m = ke, \quad \boldsymbol{h} = k'\boldsymbol{\mu}\,. \tag{1.4}$$