Image of an infinite, monoenergetic radiation field, scanned by a directional detector is analyzed. The condition for ideally true image is discussed and the method for reconstruction of the directional flux densities of the radiation field, according to the data measured by a directional detector, are given.

INTRODUCTION

An infinite radiation field /e.g, the photon field in the cosmic space/ can be characterized in a given point of space by the directional flux density \( N/E, \theta, \phi \), defined as the particle or photon flux per unit time, through unit area, perpendicular to the direction of incidence, which is determined by the azimuthal /\( \theta \)/ and radial /\( \phi \)/ angles. The symbol \( E \) designates the energy of particles or photons. If a directional detector with known properties is placed in the given point in this field and readings are taken in various directions, it is possible to specify the directional flux density \( N/E, \theta, \phi \) according to the measured readings and properties of the detector.
Fig. 1. Orientation of a detector in a radiation field

THE DIRECTIONAL DETECTOR IN AN INFINITE RADIATION FIELD

Assume a monoenergetic radiation field characterized by a value of $N/E, \theta, \phi$, with respect to the given point, where we place the centre of cylindrical coordinate system. Let us further assume an axially symmetric directional detector, which is located in the centre of the coordinate system and let the reference direction be defined by the direction of the detector axis /Fig. 1./

Radiation incident through various angles on the directional detector, orientated in the direction $\hat{\Omega}_i = \theta, \phi$, is detected with various efficiency, according to the magnitude of the detection cross section. The resulting count rate detected from the all environmental space, at the detector orientation $\hat{\Omega}_i$, is given by

$$M_i/E = \int_0^{2\pi} \int_0^\pi N(E, \theta, \phi) \sigma_i(E, \theta, \phi) \sin \theta \, d\theta \, d\phi / |l|$$