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Cherenkov X-ray radiation in a fractal medium

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This report is devoted to the radiation arising from the motion of an ultra-relativistic particle in a fractal non-magnetic medium. The concept of a fractal medium is widely used in condensed matter physics [1]. Fractal materials are substances whose fractal dimension is different from the topological one: a topological dimension can be only 0, 1, 2, 3, while a fractal dimension can be a non-integral number. Experimental methods for determining the characteristics of a fractal medium (primarily fractal dimension) are of interest. We propose to use X-ray Cherenkov radiation for this purpose. Actually, one of the most popular examples of fractal materials is aerogel –highly porous substances with a record low density for solids (and hence the refractive index); on the other hand, aerogels are widely used as Cherenkov radiators [2].

Here, we calculate the analytical expressions describing the dependence of characteristics of X-ray Cherenkov radiation on the fractal dimension of the material in which the radiation is generated. A formula is given to determine the fractal dimension of the medium based on the radiation characteristics. The role of transition radiation on inhomogeneities inside the medium is discussed. It is shown that such radiation can also be attributed to the resulting Cherenkov radiation as long as the minimum coherence length is much larger than the pore size of the medium (which is true for real fractal materials).

References

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