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Estimation of the reliability of detecting linear point structures in two-dimensional distributions of experimental data based on the Hough transform

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Unusual rectangular structures were observed for the first time using a resulting fragment mass–mass matrix in experiments on the FOBOS spectrometer studying the spontaneous fission of ^{248}Cm and ^{252}Cf nuclei. These structures are associated with a large “missing” mass and are bounded by magic nuclei, and they were interpreted as a manifestation of a new exotic decay mode – triple collinear cluster decay (TCCD). These pioneering results have been repeatedly confirmed and refined in a series of subsequent experiments. At the stage of interpreting the obtained data, an assessment of the statistical reliability of the aforementioned linear structures in the mass–mass distribution of the registered fragments is required.

This report presents the results of a comparison between assessments of the statistical reliability of point linear structures using the standard Hough transform and a modified Hough transform that offers greater robustness to noise and outliers. In the classical Hough method, each experimental point is treated as a point source of votes in parameter space. To reduce the influence of extreme points, random points are generated inside a bounding circle, which lowers the probability of false maxima along diagonal directions. However, this approach does not account for finite measurement accuracy. In this work, a Hough method has been implemented in a way that each experimental point is represented by a circle whose radius corresponds to the measurement uncertainty. The sought line is then treated as a band of finite thickness (greater than one pixel). Such a band may fully or partially overlap the “smeared” point. The simulation was carried out on a 100×100 pixel field with approximately 25 random points generated. During voting, partial intersections of the line band with the uncertainty regions of the points were taken into account. The results of both methods were compared. It is shown that the probability of a random occurrence of linear structures on the plane does not exceed 2% for either method.

Primary author(s) : FALOMKINA, Olesya (Lomonosov MSU); PYATKOV, Yuri (MEPhI); GUSEINOVA, Amina

Presenter(s) : GUSEINOVA, Amina

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