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FRACTAL STRUCTURE GENESIS OF ELECTRON-OPTICAL MOIRE ON SMALL EXTENSION MAGNETIC DISPERSION FIELDS

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Key words and phrases: electromagnetic field; field distortion by defects; moire.

Abstract: Information criteria for small volume non-uniform magnetic field evaluation as the factor of moire pattern and fractal dimension asymmetry were suggested. Dependence of these criteria on crack edge length in flat current conductor was found. It was shown that alteration of moire pattern asymmetry round hole-type distortions and edge cracks are similar to known electromagnetic energy distribution in these regions. This fact can serve as grade dimension of energy concentration round non-conducting distortions.

Fractal theory is very often applied in cases when we need to describe different objects, structures and phenomena characterized with self-similarity. According to Benua Mandelbrot assumption, integrity development cycles of hierarchically organized structures are fractal and concerned with self-organization processes. Different fractal types have one feature in common – the existence of recessive generation procedure based on self-completion or self-organization mechanisms. This process is accompanied with the appearance of a host of similar structures and pictures based on one and the same physical phenomenon.

On one hand physical affects connected with field asymmetry are fractal but violation of symmetry with preserved periodicity leads to alteration of fractal dimension. On the other hand fractal presentation of physical phenomenon by computer visualization enables to identify and recognize different mathematic and natural forms, ex. One can carry the direct observation of local magnetic field alternations round energized conductor imperfections (natural form) together with analytic description of electromagnetic energy concentration on imperfections of these conductors (mathematical form). Here fractal serves as an instrument of quantity invariant search and interpretation which are connected with magnetic measurement tasks.

The investigation of magnetic field through changing topology of electron-optical moire patterns resulted in finding out some regularities connected with distortions and richness of moire pattern, field location and intensity which appear on conductors with various imperfection geometry [1].

The fact that moire pattern is connected with moire fringe periodicity alternation and is determined by the extent of fringe richness in a moire pattern, enables us to judge upon electron-optical moire pattern fractal structure genesis on a magnetic field of conductors with structure imperfections. This kind of development was to a first approximation detected experimentally by counting sets of black and white pixels after moire pattern filtration in the information-measuring system [2]. In this case two

variable quantities were analyzed – fractal dimension df and geometric imperfection parameters. It is obviously easy to connect df with magnetic field value generated by imperfection in an energized conductor.

One should take into account the interdependence of imperfection parameters and field intensity, which in its turn is found on electron-optical moire pattern with the help of the following technique.

1. Moire patterns are filtrated in order to find sets of black and white pixels R.

2. Alternating flat set $M(R)$ is detected topographically and corresponds to the number of black pixels after filtration.

3. Fractal dimension d_f is found through the correlation

$$M(R) = R^{d_f}.$$

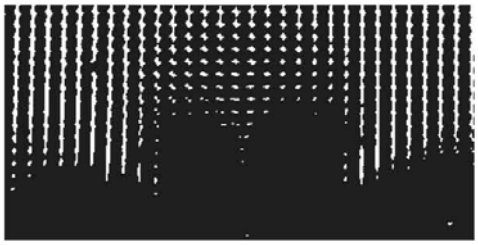
4. The degree of magnetic field distortion is evaluated through d_f alteration.

Investigating moire fractal one can find self-similarity of its structure on various steps of moire structure genesis. The uniform algorithm of moire periodicity realization is observed on different levels of moire generating. Undoubtedly this is the effect of a local magnetic field which unites pattern elementary formations varying their spacing and leaving the structure unchanged. That is why the development of electron-optical moire is connected with equal fragment alternating structure formation where dark and light bands are interchanging and due to the field under investigation can be either symmetric or asymmetric. As it was pointed out the last can characterize the field distortion degree revealing the existence of various conductor structure imperfections.

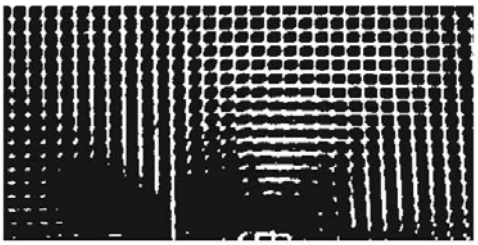
In other words one can not take away from the general moire pattern one of its fragment repeating self-similar structure without destroying the pattern integrity.

Thus fractal structure genesis of electron-optical moire pattern on small volume dispersion magnetic fields depends on object geometry, location dimensions of witness net and accelerating potential of an electron gun. The pattern distortion degree can be determined by alteration of fractal dimension d_f, which in its turn is the assessment criterion of the field distortion degree on conductor imperfections.

This can be exemplified by experimental data obtained through investigation of dispersion field distortions of multi-channel magnetic heads. The investigation was carried out in order to detect rejects. The latter was assessed by alteration of fractal dimension of perfect and rejected items by the suggested technique (Fig. 1).



a)



b)

Fig. 1. Electron-optical moire pattern of magnetic head dispersion field:
a – perfect; *b* – rejected

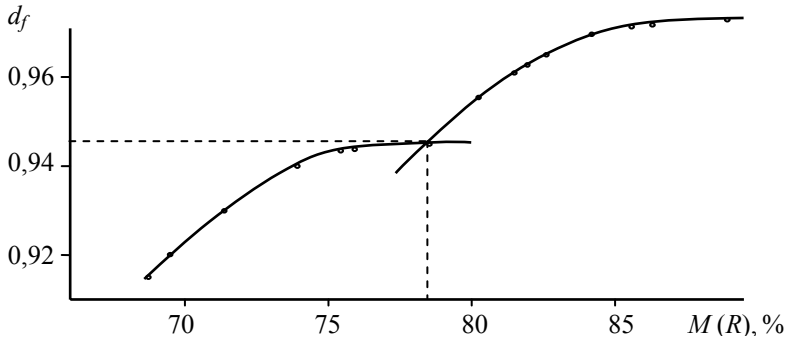


Fig. 2. Dependence of fractal dimension on magnetic field distortion degree

It turned out that there exists specific d_f (Fig. 2) which can serve as original rejecting criterion in information-measuring system for magnetic head quality control [3]. This dramatically simplifies measuring system algorithm and structure as well as increases magnetic head quality control precision and speed.

Thus peculiar characteristic of small volume magnetic field moire pattern lies in the fact that one can define the limits of its divisibility and growth, i.e. it is not infinite like many other physical phenomena in nature. Fractal structure genesis is based on recursion that is topology of fractal pattern is generated by recursion algorithm. At the same time fractal dimensions appear to be the obvious measure of magnetic field distortion of energized objects.

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Фрактальный структурогенез электронно-оптического муара на магнитных полях рассеяния малой протяженности

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Ключевые слова и фразы: искажение полей дефектами; муар; электромагнитное поле.

Аннотация: Предложены информационные критерии оценки неоднородных магнитных полей в малых объемах в виде коэффициента асимметрии муарового узора и фрактальной размерности. Найдены зависимости этих критериев от

длины краевой трещины в плоском проводнике с током. Показано, что изменение коэффициента асимметрии муарового узора вокруг дефектов типа отверстия и краевой трещины аналогично известному распределению электромагнитной энергии в этих областях, что может служить мерой оценки концентрации этой энергии вокруг непроводящих дефектов.

Fraktalische Strukturgynese des elektronenoptischen Moires auf den magnetischen Feldern des Zerstreuens der kleinen Ausdehnung

Zusammenfassung: Es sind die informativen Kriterien der Einschätzung der ungleichartigen magnetischen Felder in den kleinen Umfängen als der Koeffizient der Asymmetrie des geflammten Musters und der Fraktaldimension angeboten. Es sind die Abhängigkeiten dieser Kriterien von der Länge des Ortsrisses im flachen Schaffner mit dem Strom gefunden. Es ist aufgezeigt, daß die Veränderung des Koeffizienten der Asymmetrie des geflammten Musters um die Defekte als die Öffnung und des Ortsrisses der bekannten Verteilung der elektromagnetischen Energie auf diesen Gebieten ähnlich ist. Das kann zum Maß der Einschätzung der Konzentration dieser Energie um die nichtleitenden Defekte dienen.

Structurogenèse fractal de la moire électronique et optique sur les champs magnétiques de la dispersion de la petite surface

Résumé: Sont proposés les critères informatiques de l'évaluation des champs magnétiques non-hétérogènes dans de petits volumes en vue du coefficient de l'asymétrie du dessin de moire et de la dimension fractale. Sont trouvées les dépendances de ces critères de la longueur de la fissure de limite dans un conducteur plat avec le courant. Est montré que la mesure du coefficient de l'asymétrie du dessin de moire autour des défauts du type de l'ouverture et de la fissure de limite est analogue à la répartition connue de l'énergie électromagnétique dans ces domaines ce qui pourrait servir de la mesure de l'évaluation du coefficient de cette énergie autour des défauts non-conduisants.