Quasi-optical Resonator for Precision Measurements and Non-Destructive Testing in Gigahertz and Terahertz Wavelength Ranges.

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Intensive development of research in the gigahertz and terahertz region of the spectrum of electromagnetic oscillations requires the development of methods and means for measuring the parameters of materials of various physical nature, of various sizes and configurations. For the study of nanoscale objects, it is advisable to use multiple interaction of an electromagnetic wave with the sample under study, this regime is well realized in an open quasioptical resonator/1/ in which a high Q-factor can be obtained by using well-reflecting metal mirrors. Such resonators are very convenient for various physical experiments, and have been used by various authors for studies in centimeter, millimeter, submillimeter wavelength ranges. Objects of research in such resonant structures were ultrathin wires /2/, films/3/, small spherical samples/4/. For measurements in each of the bands, a separate resonator was created, the dimensions and reflecting properties of the mirrors provided the necessary quality for the measurements of the quality factor and the necessary spectrum of the resonance oscillations.

In this study, we consider the possibility of working in all the above ranges in a single quasioptical resonator, without replacing the mirrors, changing the distance between them, and changing the location of the studied object. It is shown that if the aperture of the mirrors is sufficiently large, the stability of the oscillations in the open resonator is achieved only by choosing the relationship between the length of the resonator (the distance between the mirrors) and the concavity radiuses of the mirrors. That is, the conditions for the existence of the caustic do not depend on the wavelength, and can be satisfied over the entire wide frequency range. An equally important condition for carrying out investigations in such a cavity is the need to isolate only one basic mode of vibration (the lowest mode), since in the presence of higher types of oscillations the measurement results are extremely difficult to interpret. When large-aperture mirrors are used to provide high Q in the low-frequency region of the spectrum, higher-mode oscillations arise in higher-frequency regions of the spectrum. The ways of their suppression are considered.

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