OLD DOMINION UNIVERSITY

COLLOQUIUM

Orbits in Superconducting RF Cavities: A Challenge for Established Physics

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Abstract

A number of data runs have been performed at TJNAF by the ALE Collaboration (with membership from TJNAF and SLAC). These runs were to study anomalous light emissions generated in the interior of high vacuum superconducting cavities (at 2 K) under (1.5 GHz) RF excitation. These light emissions and their associated phenomena were observed by a small monochrome video camera, looking through a standard optical viewport, as well as by other instrumentation. Of the several phenomena observed, the most perplexing are what appear to be small luminous long-lived objects moving about in the vacuum space in the interior of the cavities without wall contact. In our several runs, more than a dozen (closed) orbits of these **M**obile **L**uminous **O**bjects (or MLOs) were observed, five of which lasted longer than 10 s. These orbits were often elliptical or near elliptical. Orbital frequencies ranged from 5 to 80 Hz. Perhaps the most spectacular orbit, taken on the last run, orbited for ~40 s (at ~40 Hz) about the cavity axis. By using reflections in the wall of the cavity beam tube it is be shown that the trajectory of this 40 s orbit was in, or near, the equatorial plane of the cavity and did not contact the cavity walls. A most intriguing feature of this orbit was a combination of orbital precession and rocking motion (spanning about 70°) having a rocking period of about 5s.

Of the various anomalous luminous phenomena in the data, these long-lived orbiting MLOs present the greatest challenge to theoretical explanation. To proceed with an analysis, the MLO physics is partitioned into internal and external. While the internal physics is as of yet unknown, an analysis of the external physics, that is the MLO orbits, is straightforward.

Using the data as a guide, it is argued that the MLOs are coherent entities of small size (≤ 2 mm) and carry a certain mass. Thus, one expects them to obey Newton's equations. Then, MLO models are formulated by characterizing these (small) entities by various electromagnetic features (charges, dipoles, etc.) that can interact with the cavity environment. It is observed that one does not have to understand the internal MLO dynamics that lead to these assumed electromagnetic features; given the specified electromagnetic features of the (model) MLOs, the analysis of the external MLO dynamics will still be valid.

Based upon the character of the experimentally observed orbits, five criteria are developed that a satisfactory theoretical explanation for the MLO orbits would have to successfully address. A number of model MLOs are analyzed in detail. Some models are more successful than others, but it is shown that none of the models that are considered have a viable parameter space that can accommodate all five of the orbital criteria. It is further argued that the set of models analyzed herein exhausts the plausible MLO modeling possibilities available from the realm of established physics. This line of argument leads to a challenging conclusion.

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