

Whispering Gallery phenomena at St. Paul's Cathedral

The very curious and interesting acoustical effects observed in the Whispering Gallery under the dome of St. Paul's Cathedral have, as is well known, been explained by the late Lord Rayleigh as due to the curvilinear propagation of sound, the waves which proceed from a source placed close to the wall of the gallery clinging to its surface and creeping tangentially along it. This view was developed mathematically by Lord Rayleigh (*Scientific Papers*, 5, p. 617), the theoretical conclusions arrived at being (a) that the sound-waves travel in a comparatively narrow belt skirting the wall, the thickness of this belt decreasing with the wavelength of the sound; (b) that in this belt the intensity is a maximum near the wall and decreases rapidly and continuously as we proceed radially away from it; and (c) that the intensity does not fluctuate markedly as we proceed circumferentially parallel to the wall.

We were much interested in the subject, and by the courtesy of the authorities of the cathedral have been enabled to carry out an extended series of observations in the gallery with the view of making a precise test of Lord Rayleigh's theory. Our experiments show conclusively that while the indication of theory as expressed in (a) is substantially accurate, neither of the conclusions (b) and (c) is in accordance with actual facts. Using a steady source of sound placed close to the wall at one point, we found that elsewhere the intensity of the sound showed pronounced oscillations in proceeding inwards radially from the wall, the ear of the observer passing several times through alternate zones of great intensity and of comparative silence. In the latter some of the overtones of the source could be heard clearly, while the fundamental was practically inaudible. These alternations of intensity could be demonstrated in the gallery, using a fairly high-pitched source and a sensitive flame as indicator. The distance between the successive zones of silence was about the same as the half-wavelength of the source. There were also distinct periodic fluctuations of intensity in proceeding circumferentially—that is, parallel to the wall. The latter were not equally distinct in all parts of the gallery, being most marked at the other end of the diameter containing the source.

The circumferential fluctuations of intensity might be interpreted as being, at least in part, due to the stationary interferences of waves which meet after passing in opposite directions round the gallery. But the radial fluctuations are less easily explained, and must be regarded as fundamental in any satisfactory theory of the Whispering Gallery. We find that effects similar to those we observed at St. Paul's

may be demonstrated in the laboratory with any large circular reflecting surface, using a bird-call with a sensitive flame as sound-detector.

The experiments thus show that, while the explanation put forward by Lord Rayleigh is at least on the right lines, it is far from being a completely satisfactory theory of the Whispering Gallery. We propose at an early opportunity to go more fully elsewhere into the question of the revision necessary in the theory.

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