Mechanism of Supernumerary Rainbows

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Have you ever seen supernumerary rainbow? This is observed a little inside a main rainbow under some rare weather condition. When rainbows are seen in nature, the size of the water droplets is usually large, such being often the cases in evening. How does the size of the droplets influence mechanism and condition of the supernumerary rainbow ? This is the main problem we focused on in this work. We studied the mechanism of the supernumerary rainbow tracing laser light rays passing through a Petri dish filled with water, and roughly identified two virtual point light sources that create supernumerary rainbow as an interference fringe. Thus the supernumerary rainbow is caused by an interplay of geometrical optics and wave optics. Next, we succeeded to actually observe the supernumerary rainbow with a mist generated by a blower , and investigated how the appearance of the supernumerary rainbow, including higher order ones, is affected depending on the size of the water droplets. The results showed that the more homogeneous and the smaller water droplets are , the more clearly and the more inward from the main rainbow the supernumerary rainbow is observed. The distance of the supernumerary rainbow from the main rainbow is found to be inversely proportional to the size of the water droplets. In nature, the best chance of observing the supernumerary rainbow is after a light rain, not a heavy rain like an evening shower in Japan. Observation and analyses of supernumerary rainbow would be useful for meteorological application.