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Great Balls of Fire

Scientists finally succeed in producing ball lightening in the lab

Ball lightning - a slow-moving ball of light that is occasionally seen at ground level during storms - is a rare phenomenon that puzzled scientists for centuries. For a long time it was even believed to be a myth or a purely psychological phenomenon. However, researchers in Israel have now managed to recreate such balls of fire under controlled conditions in the lab. Ball lightning is photographed very rarely (this is a 1987 picture taken by a Japanese student), and details of witness accounts are often in conflict with each other. They sometimes appear during thunderstorms as a consequence of usual lightening, but there have been reports of ball lightening even during good weather. Their shape can be spherical, ovoid, teardrop, or rod-like and they float slowly through air. The biggest ball lightning seems to have been between around fifteen and forty centimeters. There were several attempts to recreate them in laboratory but until now they all failed to give conclusive results. There are several theories about what ball lightning might be. The most popular one is that they are balls of plasma that remain contained due to their self-generated magnetic fields. Plasma is a gas of ionized molecules and electrons. Although plasma has an overall neutral electric charge, at small scales it is charged. As they move, these electric charges (ions and electrons) produce magnetic fields. However, plasma theory predicts that in order for such a self-contained ball of plasma to exist due to its own magnetic fields, it would have to be extremely hot - i.e. the particles should move very fast in order to generate sufficiently large magnetic fields. Thus, due to the fact that hot gas is lighter than cold gas, such a ball of hypothetical plasma should rise up into the atmosphere very fast. But this is not what one observes in case of ball lightning. The Israeli team of scientists used a different idea. They believe that ball lightning is produced during storms by a bolt of lightening that strikes the ground and creates a molten "hot spot". This causes vaporized mineral grains from the soil to rise up into the atmosphere. These grains are the "seed" of the ball lightning. In addition to the plasma that forms around them and which emits light, they are also involved in chemical oxidation reactions - i.e. they burn. Thus, a ball lightning is like a combination between a torch and a fluorescent (plasma) light bulb. Eli Jerby and Vladimir Dikhtyar from Tel Aviv University have recreated such balls of fire in their lab using a "microwave drill". The device is similar to a 600-watt domestic microwave oven with the exception that it concentrates all its power into a volume of just one cubic centimeter. The researchers pointed the microwaves inside a solid substrate made from glass, silicon, germanium, alumina or other ceramics. The energy from the microwaves produced a molten hot spot in this substrate and then the scientists pulled the microwave drill out of the solid, dragging the molten hot spot. Once in the atmosphere, this hot drop became a floating fireball that measured about 3 centimeters across and lasted for some tens of milliseconds. "The fireball looks like a hot jellyfish, quivering and buoyant in the air," says Jerby. Thus, they have managed to recreate a miniature ball lightning. "Our ability to generate such fireballs in a simple systematic manner may lead to techniques for synthesizing fireballs from solid materials," explains Jerby. He even hopes that these lab-generated fireballs could have practical applications such as coating, deposition, combustion and energy production. *Photo credits: E. Jerby (Eli Jerby, on the left, and Vladimir Dikhtyar producing a fireball in the lab)*