Great Balls of Fire Produced by Radon Decay?

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Hessdalen lights (HL) are unexplained lights usually seen in the valley of Hessdalen, Norway [1]. It has the appearance of a glowing light-ball with dimensions ranging from decimeters up to 30 m. In few cases (at low level of luminosity) it explicitly shows visually some kind of geometric structure. The reason for these shapes is totally unknown. HL is characterized mostly by white color and sometimes by red color. It occurs mostly at night, more often in the winter season (in the absence of thunderclouds) and with a peak around midnight. It shows a very strong IR track (from a non-recording Night Vision System) also when it is very faint in the optical range or invisible. It appears very often some tens of meters over the top of the hills. HL sometimes oscillates. The frequency of this oscillation is of about 7 Hz [2]. In this work, it is showed that Hessdalen light (HL) is formed by a cluster of Coulomb crystals in a dusty plasma produced by ionization of alpha particle during radon decay in the atmosphere (Figure 1).

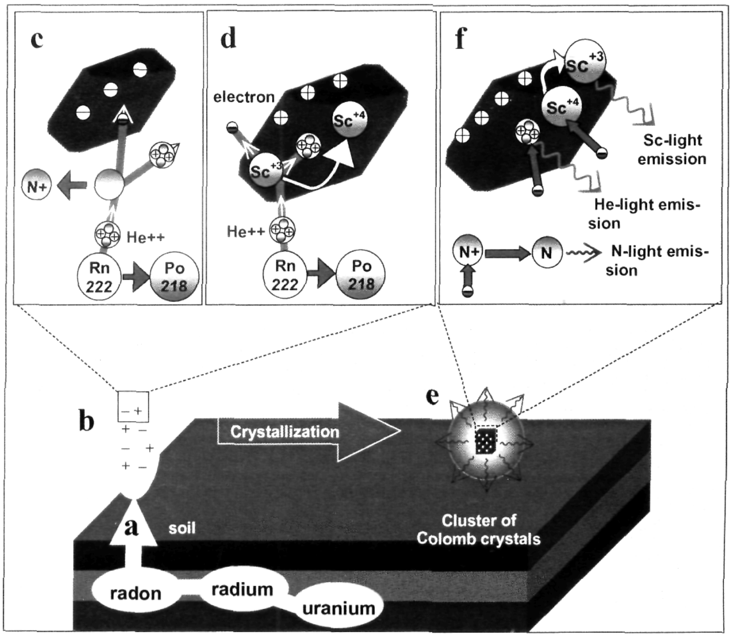

Fig. 1- Norway is considered to be one of the most radon-affected areas in Europe. Radon is continuously produced by radioactive decay of ^{226}Ra present in rocks. HL is produced when high concentration of radon gas migrates through faults and fragmented soils to the atmosphere (a). High energy (~ 5.48 MeV) alpha particles from radon decay ionize the atoms (from air, water or dust) in its path. A dust aerosol particle (thortveitite of terrigenic origin of sedimentary mater, $(Sc,Y)_2Si_2O_7$), like any surface exposed to a ionized gas (b), is charged by collecting electrons (c) or positive ions (d) (by alpha particle capture or secondary electron emission by the grain). Crystallization of dust plasma will form a cluster of Coulomb crystals (e) that emits light by electron capture (f)

Coupling parameter G in a dust plasma depends on the ratio of the square of the particle charge and particle temperature, $G= [Q_P^2 \exp(-a_P/\lambda_D)]/4\pi\varepsilon_0 a_P k_B T_p$, where Q_p is the charge on the grain, a_p is the interparticle distance, k_B is the Boltzmann constant, ε_0 is the permittivity of vacuum and T_p is the particle temperature and λ_D is the Debye length. The electron density for HL can be estimated as $n_e \sim 10^{18}$ m^{-3} (considering HL as low-density plasma, such as flames [3]). For the sake of convenience, assuming the steady state (initial) surface temperature of a particle to be $T_p = 350$ K [4], dust particle radius $r = 10$ μm (soil dust grain), typical interparticle distance of the order of 10^2 μm [5], and $\lambda_D = 5$ μm, we found a coupling plasma parameter $\Gamma \sim 4x10^7$. Monte Carlo simulations showed that the charged species in a dusty plasma should form regular lattices (Coulomb Crystals) at $G \geq G_c$, where $G_c = 170$ (or $G_c \sim 178$) is the critical coupling parameter for the liquid-solid transition [6]. Typical laboratory dust plasmas present Coulomb crystals of 1 millimeter-size for a plasma parameter of the order of 10^4 [7]. Taking into account that the proportion rule between Crystal size and coupling factor is linearly valid, we can predict that HL will have a Coulomb solid in its center of about 1 meter-size for a coupling factor of $\Gamma \sim 4x10^7$. Depending on the particle density, different geometric structures of Coulomb crystals should arise in a dust plasma: three-dimensional structure (cubic), and the other is simple (rectangular, squared, diamond-shaped, or hexagonal), so called two-dimensional structure [8]. On the other hand, in most cases HL (at high level of luminosity) if seen from far away, it has the appearance of a glowing light-ball with no structure, in other cases (at low level of luminosity) it explicitly shows visually some kind of geometric structure [1]. Rectangular shapes have been recorded as well. This shapes (recorded on 1/30 sec video frames), in particular, is not simply a result of videocamera pixilation effects, since the same kind of shape is recorded by conventional photographs. In a specific case, the rectangular shape is much smoothed owing to fast motions of satellite-spheres around the rectangular core during a long-time exposure.

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