On the quest of microorganisms in space

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Microorganisms such as prokaryotes are found everywhere; deep sea with high pressure, around hydrothermal vents and in hot springs with high temperature, and so on. Many researchers have searched such extremophiles (organisms that prefer living or can survive in extreme environments) in various regions on earth.

The upper layers of the atmosphere such as upper layer of troposphere and stratosphere are the one of the frontiers for the quest of microorganisms.

We have performed air-sampling experiments for collection of microorganisms using airplanes and balloons. By the experiments using airplanes, we could collect air-samples up to approximately 10 km high, and we obtained some bacterial strains from the air-samples (Yamagishi et al. 2005, 2006). By the experiments using balloons, we succeeded in collecting air-samples from 20 km to 30 km high (Yamagishi et al. unpublished result). From the air-samples, we could also obtain multiple bacterial strains. Some bacterial strains isolated from the air-samples show extremely strong resistance to ultraviolet radiation. They are more tolerant than *Deionococcus radiodurans* that is known as one of most ultraviolet radiation tolerant organisms.

Our next question is whether we find any microorganisms at higher altitude than, for instance, 30 km high. Balloon cannot be used for air sampling at higher altitude than that we tested. Rocket is not suitable for air-sampling experiment because of too short sampling time at respective altitude, although the meteorological rocket has been used in the pioneering experiment performed at 1970's.

The international space station (ISS) stays at approximately 400 km high. Can we collect microorganisms at this altitude? At this altitude, the atmospheric pressure is nearly zero, so that we cannot use the air-sampling method for collection of microorganisms. In addition, relative speed between ISS and particles in the orbit is some km/s to 16 km/s. Therefore, if we try to collect microorganisms at this altitude, we need a method that can catch the samples approaching at up to 16 km/s.

Recently, silica aerogel with extremely low density (lower than 0.05 g/L) has been used to collect small particles in space experiments. Because of its low density, damage of the particles attacking the aerogel is reduced. Can we use the aerogel to collect microorganisms attacking at some km/s? To test it, we planed the experiment . In the experiments, microorganism samples were accelerated to 4 km/s by using the two-stage light gas gun, and targeted at the aerogel

We performed the preliminary impact experiments with freeze-dried bacteria samples with/without argillaceous materials (such as montomorillonite) to check whether we can detect microorganisms (or its traces) after impact at some km/s. In our presentation, we will discuss the results of the preliminary impact experiments of bacteria samples, and review the possible application of aerogel for collection of microorganisms with high speed (some km/s) at the altitude of ISS.

References:
Yamagishi, A. et al. Space Utilization Research. 21:277-279 (2005)
Yamagishi, A. et al. Space Utilization Research 22:326-328 (2006)