Leak on International Space Station -- 2020

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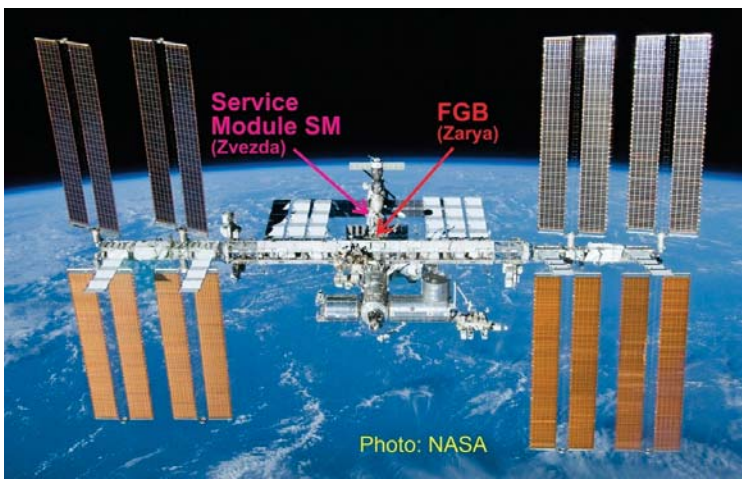
Recent days witnessed significant increase in leak of air from the International Space Station.

A small leak was first detected in September 2019. Its rate doubled in the late August of 2020. The ISS crew, cosmonauts Anatoly Ivanishin and Ivan Vagner and astronaut Chris Cassidy, isolated different parts of the station, trying to pinpoint the leak. No success then.

A few weeks later in September, the rate increased again. The crew identified now a section of the ISS Service Module (SM, or Zvezda) where the leak is located (photo below). Launched in 2000, SM became the third ISS module that together with the earlier launched FGB (Zarya) and Node-1 (Unity), served as the "founding" building blocks of the station. SM plays a major role in the life support system of the entire International Space Station.



A Russian information agency, RIA, reported on September 29, 2020 (with references to Roscosmos) that the leak had increased to 1.4 kg per day with the associated "general atmospheric pressure drop at the level of 1 mm [of mercury, or torr] in 8 hours." The latter number means 3 mm Hg (or torr) per day.

Recall that in August 2018, an obscured drill hole caused a leak in a Russian Soyuz MS-09 vehicle docked to ISS. I posted then a short video on YouTube analyzing (with related equations) the leak -- https://youtu.be/5q1G1-m2zGw.
Let us apply a similar analysis to the current leak and put it into perspective.

First, there is inconsistency between the reported pressure drop and mass loss. For a total mass of air on ISS 1100 kg and mass loss of 1.4 kg/day, the associated pressure loss should be about 1 mm Hg (or torr) per day, about three times smaller than the reported rate. It is likely that additional air is added from the ISS storage which could explain this discrepancy.

If the 3-torr/day pressure loss is correct, then the mass loss is about 4.4 kg/day or 0.051 g/sec. This mass loss is about 15 time smaller than the mass loss due to the drill hole discovered in 2018.

The current leak could be caused by a perfectly shaped opening with an area of about 0.2 square millimeter. All real holes are not perfectly shaped (this is described by the so called discharge coefficient), so the opening area is actually a little larger, perhaps 0.6 mm (3/128") in diameter. If it is a narrow long slit (such as a crack), then the effective area would be larger.

Dealing with a small leak is not a major problem logistically or financially. Mass loss of 4.4 kg per day translates into 1600 kg per year. At a cost of $10,000 for delivery of 1 kg to ISS, it would require only $16M each year to replenish the lost air.

The real problem is that the leak could become bigger and develop into a larger and dangerous problem. It is essential to find it and seal as quickly as possible.

Finding small leaks is very difficult. (Incidentally, not that anybody asks me, finding a technical solution could be an excellent and urgent topic for NASA's SBIR program.)

Ad astra.