Venus Laputa: A sustainable N2-filled platform in the Venus atmosphere. M. Yamauchi[1], O. Norberg[1], S. Watanabe[2], R. Laufer[3], N. Ivchenko[4], and C.-F. Enell5
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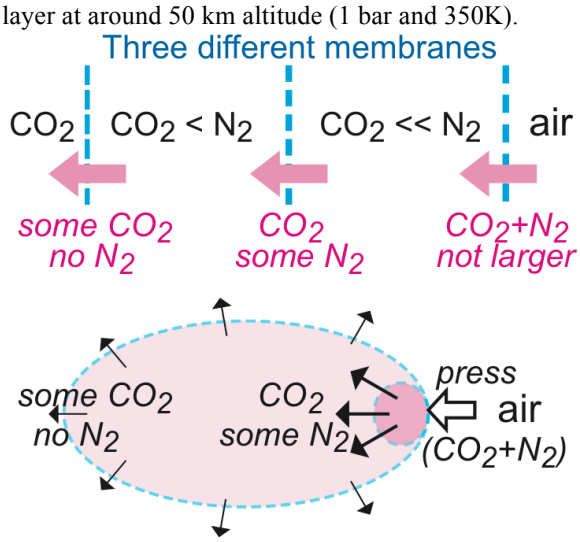
Introduction:

For planets and moons with dense atmospheres such as Venus, Titan, and Triton, a floating platform in the atmosphere like a balloon or an unmanned aircraft is desirable, particularly inside and under the thick clouds, which is full of dynamics and chemical/electric processes. The problem with traditional Helium-gas balloon platforms is that they cannot last many months due to the leak of gas through the skin.

New Idea: To solve this, we propose to use N_2 as the filling gas for the main buoyant structure (balloon or airship) because N_2 gas does not easily leak, thanks to much larger kinetic diameter (3.6 Å) than those of CO_2 (3.3 Å) and He (2.6 Å). For an example, permeability through Ethylene–Vinyl Alcohol Copolymer films is more than three order of magnitude smaller for N_2 than He. Although heavier than He (4 amu), N_2 (28 amu) still provides half the buoyancy force in the CO_2-rich Venus atmosphere (~40 amu), compared to He in the Earth atmosphere (~29 amu). Even with 80-90% concentration of N_2 (rest is CO_2), the buoyancy force is enough to keep this platform floating in the CO_2-rich atmosphere near the cloud layer at around 50 km altitude (1 bar and 350K).



The permeability of N_2 through a membrane is even smaller than that of CO_2 (less than 3%). This opens up a possibility of local extracting N_2 from the CO2 atmosphere with 3.5% of N_2 on the floating platform, if the sufficient power is provided. One rough concept is drawn in the figure. Instead of static "take out" of N2, we consider dynamic system that keep removing CO_2 from the balloon system with three different membranes: first layer removes heavy molecules like water drop and H_2SO_4, second layer keeps some N_2 but transmits almost all CO_2, and the third layer keeps N_2 while transmitting some CO_2.

If such local production is realized in the Venus atmosphere where solar power is limited du to think cloud, we can aim floating observatory that lasts many years. In such a case, the platform should cover all latitude with active control of the destination, quickly traversing the night side. Therefore, airship type with wings and propeller should be aimed rather than simple balloon for this "Laputa" platform.

Other application: As a spin off, such developments will be beneficial to both terrestrial observations (concept can be applied to the Earth for example as volcanic monitor) and environmental issues (separating CO2 from the atmosphere and solar cells in challenging environments).

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