Stability and Instability of Earth and planetary systems: the occurrence of the snowball and the runaway greenhouse states.

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It is an interesting question whether the Earth and Planetary systems are stable or not. An intuitive understanding of stability and instability of the system can be somewhat different from those rigorously defined criterion in mathematical physics. Here, we consider the occurrence of the snowball state (or the completely frozen state) and the runaway greenhouse state (or the completely vaporized state) as a typical example of stability problem of the Earth and planetary environment. We discuss these phenomena in terms of stability, instability and multiple solution with a simple mathematical model. Then, we compare the predictions from the simple mathematical model with the results of more complex models, and more realistic situations.