

Is Earth's tilt a resonance?

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Abstract. The reason why we have seasons is that the Earth's rotation axis is tilted. An interesting fact that the sine of the tilt is almost exactly $2/5$. This fact leads to a natural question: is this an indication of a physical resonance – or is this a random coincidence? In this talk, we show that this is an accidental coincidence.

Earth tilt: its importance and its value. The orbits of all the planets of the Solar system lie in the same plane. The rotation axes of all the planets are approximately orthogonal to this plane. However, each actual rotation axis is somewhat tilted in related to this orthogonal direction. This tilt is the reason why, in most places on Earth, we have four seasons:

- Winter, when this location is tilted away from the Sun and thus, gets the smallest amount of the Solar radiation energy;
- Spring, when the amount of Solar radiation increases;
- Summer, when this located is tilted towards the Sun and thus, gets the largest amount of the Solar radiation energy; and
- Fall, when the amount of Solar radiation decreases.

Specifically, the Earth's tilt is 23.4° .

An interesting fact about the Earth's tilt. Sines and cosines of the angles appear in many formulas describing a system's dynamics. Interesting, the sine of the Earth's tilt angle is almost equal to $2/5$:

$$\sin(23.4^\circ) = 0.397 \approx 0.4 = \frac{2}{5}.$$

Why this is an interesting fact – and the resulting question. This fact is interesting because usually, unit-less combinations of physical quantities are generic real numbers, and it is very rare that their value is close to a fraction of two small integers. In most cases when we have such an exceptional ratio, this value is caused by a *resonance* – a known physical phenomenon according to which two nearby pendulums (or other periodic processes) eventually get synchronized:

- if their frequencies were close to each other, they become equal;
- if one of the frequencies was almost twice larger than the second one, it becomes exactly twice larger, etc.

For example, in the past, the period of the Moon's rotation around the Earth was close to – but different from – the period of its rotation around its axis. However, with time, these periods became the same, so now, from the Earth, we can only see one side of the Moon.