Out on the pull: Why the moon always shows its face

March 27 2013, by Jonti Horner

The moon has no choice but to show its good side. Credit: Nuranna

Technically, Pink Floyd had it wrong. The space-facing side of the moon isn't dark (except at full moon when the Earth is between the sun and the moon). Not that you'd know that, given we always see the same side of our nearest neighbour.

To understand why we only see that one side, we need to explore the relationship between the moon and Earth, and the forces that will slowly, but inexorably, sling the moon from our orbit into space.

As the moon orbits Earth, its gravitational pull raises "tidal bulges" on our planet. Both solid ground and oceans respond to this pull, causing the moon to raise land and ocean tides.

At the same time, the sun also raises tides on Earth which, while noticeably weaker than those caused by the moon, adds a level of complexity to the tides we experience.

When the moon and sun are aligned correctly (either at new moon – when the moon is approximately between Earth and the sun – or at full moon, when Earth is approximately between the moon and the sun), the tides induced by the moon and sun add together, and we get extra-high and extra-low tides. These are commonly known as "spring tides".

Equally, when the moon and sun are pulling at right angles to one another, their influence cancels out, to some extent, and we get "neap tides" – high tides are at their lowest, and low tides their highest.

Slow spin-down – the long-term influence of tides

Beyond just causing the daily ingress and egress of the ocean onto land, tides raised by the moon on Earth have another interesting effect – they are slowly causing Earth's rotation to slow.

As we all know, Earth spins on its axis once a day, but the moon takes almost a whole month to orbit our planet. As a result, the location of the tidal bulges from the moon move around our planet significantly more slowly than Earth's surface spins.

Friction causes the bulges to be pulled along with Earth's motion, to some degree, and they end up slightly ahead of the location directly beneath the moon.

While friction with Earth tries to pull the bulges ahead of the moon, the moon's gravity tries to keep the bulges aligned beneath it. The end result of this conflict is to cause Earth to slowly spin down, losing rotational energy to the drag from the tidal bulges.

That energy is transferred to the moon, causing it to speed up in its orbit, and therefore gradually swing away from Earth.

We're slowly growing apart – the moon's recession

The rate at which the moon is receding from Earth is relatively small, but easily measured (using the retroreflectors left on the Moon's surface by the Apollo astronauts, among other techniques).

Currently, the recession is only around 22 millimetres a year, causing one Earth day to lengthen by about 23 microseconds a year.

While that doesn't sound like much, it means the moon was once much closer to Earth, and Earth was spinning far faster than its current 24-hour rotation.

Again, these are both properties best explained by the "big splash" that created the Earth-moon system.

Synchronous rotation

Interestingly, that same tidal evolution is the reason the moon now keeps one face continually pointed towards Earth.

Earth exerts tides on the moon, just as the moon exerts tides on Earth. Since Earth is comparatively massive, the tides it raises on the moon are much greater than those raised by the moon on Earth. And those tides long ago slowed the moon's rotation so that it spins on its axis exactly once in the time it takes to orbit our planet once. This is called "1:1 spin-orbit resonance" or synchronous rotation.

As the moon recedes from Earth, its orbital period will increase, but the strength of Earth's tides will ensure its spin slows, so it will always continue to show the same face to our planet.

More information: I see the moon: Introducing our nearest neighbour: phys.org/news/2013-03-moon-nearestneighbour.html

This story is published courtesy of The Conversation *(under Creative Commons-Attribution/No derivatives).*

Source: The Conversation