

Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *The Moon does not spin on its axis*.

It is my pleasure and privilege to be a junior member of the writing team for the fabulous Universe Today website – and one day wrote on story on a recent speculative finding that the exoplanet WASP12-b had a magnetosphere – and just to give the story a bit of balance, I naively finished with a speculative statement of my own which said:

There is at least one puzzle here, not really testable from such a distance. Presuming that a planet so close to its star is probably tidally-locked, it would not be spinning on its axis – which is generally thought to be a key feature of planets generating strong magnetic fields – at least the ones in our Solar System.

So that all seemed fine – and then I clicked publish – and then, the horror... as the comments started flowing in. Suddenly I felt like Galileo in front of the Inquisition – *Recant! Heretic!* – or some misshapen wretch pursued by villagers with pitchforks. Folks, I had committed the eighth deadly sin of outreach astronomy – suggesting that a tidally locked object in orbit does not spin on its axis.

So here's the deal. Let's say you're standing on the surface of the Moon. I think we can at least agree that the Moon is tidally locked in Earth orbit – only ever showing one face to the Earth as it goes around and around.

Now, it certainly true that on the surface of the Moon you would experience a diurnal cycle with sunrises and sunsets about two weeks apart – and the star field would appear to rotate around you. However from one and from only one side of the Moon you would see this big blue planet that just hung there not moving. At your lunar midnight its face would be fully lit, that is a full Earth while at your lunar midday it would its face would be completely dark, that is a new Earth.

So, just on this basis, no-one should have a problem with the fact that the Moon is rotated through 360 degrees for every orbit it makes around the Earth. What I don't get at all is the conclusion that it therefore spins once on its axis for every orbit it makes around the Earth.

And look I acknowledge am a complete heretic on this one. If you google *Moon spins on its axis* you will find hundreds of websites confirming this to be true – including Wikipedia.

Well, there is at least one possible exception. The inimitable Dr Phil Plait discusses the issue as follows:

Bad astronomy: The Moon only shows one face to us because it is not rotating.

Better astronomy: The Moon only shows one face because it *is* rotating, once every time it revolves around the Earth. (*I prefer saying 'is being rotated', but OK*)

Best astronomy: The Moon does not appear to rotate in the reference frame where the Earth-Moon line is fixed in direction, but it does rotate as seen by an outside observer. (*Exactly*)

This is a well articulated explanation and in my view defines a solution for how we should describe the behaviour of a tidally locked object in orbit. It is being rotated, as a consequence of it being fixed – not spinning - fixed into a tidally locked orbit.

So sure, there is a particular frame of reference you can choose where you will observe the Moon to rotate – and seemingly on its axis, but there are equally valid frames of reference, like from the surface of the Earth, where it most definitely does not rotate. All these perspectives are correct. So, before you should say anything about rotating (or spinning), you need to refer that statement to a particular frame of reference.

So, that's my first point – if you want to insist that the Moon is spinning on its axis you have to first specify the frame of reference from which you are drawing that conclusion – because there are some frames of reference in which you will be wrong.

And from there, let's do a bit of a thought experiment. Imagine the Moon really was spinning on its axis. And come on, you know exactly what I mean by that statement.

If the Moon really was spinning on its axis then not only would there be sunrises and sunsets, and not only would the star field appear to rotate, but the big blue planet Earth in the sky would also appear to rotate about you.

Even more importantly, let's imagine this Moon had a molten interior. If it was really spinning (and come on, you still know what I mean) really spinning on its axis, then that molten interior would also spin potentially generating a magnetosphere through the sort of dynamo-like effects that produce magnetospheres.

Now if instead this imaginary Moon with a molten interior is tidally locked in orbit - and hence is just being rotated through 360 degrees once per orbit, you are not going to get that same effect. Instead the molten contents will predominantly experience an outwardly-directed centrifugal force, which will always be directed towards the same side of the Moon at all points along its orbit.

So there are fundamental physical and dynamic differences between an object that is really spinning on its axis and one that is tidally locked and is being rotated once every orbit. That's my second point.

My third point is this issue of the Moon rotating – or spinning if you must - on its axis. What axis? OK if you look at the Moon being rotated once for every one of its orbits – sure it's being rotated in a particular plane – being its orbital plane around the Earth. Then I suppose you could imagine there's a line running through its middle, perpendicular to its orbital plane that, from a very specific frame of reference, might appear to be its axis of rotation.

But then look at the Earth – which is really spinning on its axis – and we know that its axis is tilted to its orbital plane around the Sun. I mean no-one is jumping up and down saying – oh no, the Earth's real axis is an imaginary line perpendicular to its orbital plane.

And you know why no-one's saying that? Because the Earth *really does* spin on its axis. It's an intrinsic spin – a real, proper spin. I don't have to refer to an absurdly specific frame of reference from which it looks like it's spinning. It is spinning. From nearly every frame of reference you can imagine – it's spinning and on its axis and everyone agrees where that axis is. I mean, come on.

Ahem, sorry. If anyone would like to comment on this podcast, please write to: MoonNotSpinningOnItsAxis@BurningAtTheStake.com

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website where we said the Pioneer anomaly was a load of old bollocks too*. No ads, no profit, just good science. Bye.

(*on *365 Days of Astronomy* 15 December 2009:

<http://365daysofastronomy.org/2009/12/15/december-15th-anomalies/>.)