Tides

Tapping, Ken

Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/23000166
Skygazing: Astronomy through the seasons, 2014-08-12

TIDES

Ken Tapping, 12th August, 2014

For anyone living by the sea or visiting it for a holiday, the tides are intriguing things. Each day the water advances and recedes twice, washing the beach and rocks and bringing in new things for beachcombers to find. They also make it possible to see sea creatures that are normally underwater. We know that the tides are due to the Sun and Moon. However, that short statement does not do justice to all the interesting things going on.

When we are in a vehicle turning a corner, or on one of those fairground amusements that involves going in circles or around sharp corners at high speed, we feel a strong outward force that is often called “centrifugal force”. Actually, it is not a real force; it is the mass of your body resisting being pushed around a curve. On the other hand, using that term makes the discussion a bit easier.

We often consider the Moon to be orbiting the Earth. Actually they are orbiting each other, about their common centre of gravity. Imagine the balance point of a dumbbell with one end 81 times the mass of the other. An object in orbit remains so because of a balance between gravitational attraction pulling inwards, and centrifugal force pulling outwards. Actually this balance only occurs at one place, at the centre of the body.

Since all parts of the Earth remain more or less together, orbiting as one object, the side of the Earth facing the Moon is moving too slowly for centrifugal force to balance the Moon’s slightly stronger gravitational pull, so the ocean gets pulled up into a bump. So does the land, but less so. The other side of the Earth is moving too quickly to maintain orbit, so the centrifugal force pulls outwards more strongly than gravity pulls inward, so again the sea is pulled up into a bump.

Since the two bumps on opposite sides of the Earth remain more or less in line with the Moon, which orbits the Earth in 29 days, while the Earth rotates once a day, every point on Earth other than the poles passes through the tidal bumps twice a day. We see this passage through the bumps as “high tide”. Unfortunately things are made more complicated by land masses slamming into the bumps, and friction with the seabed. This means that the rotating Earth pushes the bumps forward, slightly out of line with the Moon. The resistance the Earth encounters pushing through the bumps, and resistance of the body of the Earth to this tidal flexing slows the Earth’s rotation and lengthens the day by about a thousandth of a second a century.

If you have ever played with a ball that is attached to about two metres or so of elastic you will have noticed something strange happens when you are trying to swing the ball in a circle. If you have never tried this and want to, do it outside, well away from breakable things and wear safety glasses. Once the ball is circling, try going faster. You will see that your hand is no longer exactly between you and the ball, it is a little ahead, so part of the force you exert goes to accelerating the ball, but instead of speeding up, the elastic stretches, and the ball moves further away and slows down. The bump on the side of the Earth facing the Moon is pushed ahead by the rotation of the Earth, and its pull causes the Moon to move further away by about 4 centimetres each year.

At the moment the Moon covers the same amount of sky as the Sun, so that when the Moon gets between the Sun and Earth we have the spectacle of a total eclipse of the Sun. There will come a time in the future when the Moon is too far away and no longer can cover the solar disc. So we should enjoy those eclipses while we have time.

Venus shines brightly in the predawn twilight. Saturn lies in the southwest during the evening, with Mars a little lower and further west. The Moon will be Full on the 10th. Remember the Perseids on the night of 12th August.

Ken Tapping is an astronomer with the National Research Council's Dominion Radio Astrophysical Observatory, Penticton, BC, V2A 6J9.

Tel (250) 497-2300, Fax (250) 497-2355

E-mail: ken.tapping@nrc-cnrc.gc.ca