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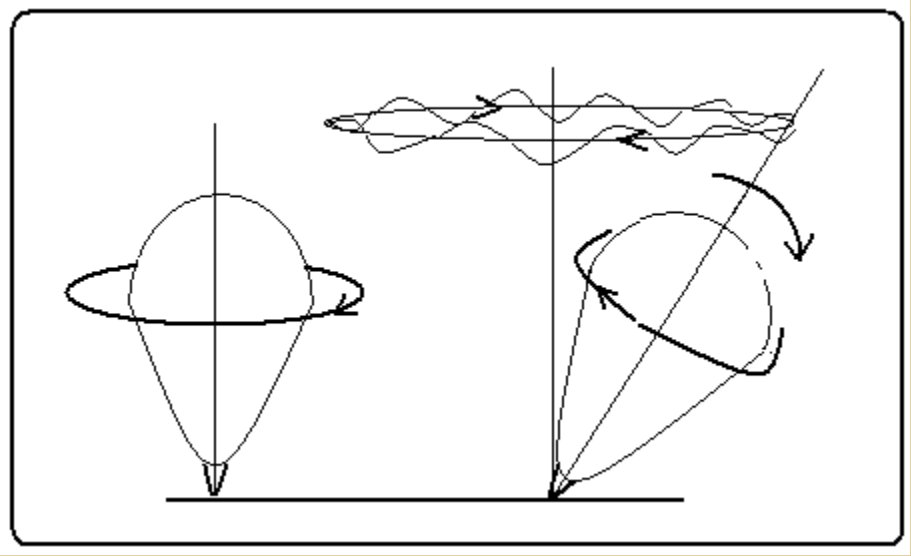
The weather, cyclone and volcano

The principle of the spinning top affects many things in nature, says S.Ananthanarayanan.

The spinning state is stable in many ways. We all know of the flywheel, which is a heavy rimmed wheel, very difficult to get going, but which can store energy for a long time. The earth and planets, in their rotation and periodic orbits have stayed in the same way for millions of years. But a more interesting property of things that spin is that they do not react directly to disturbing influences and can keep their orientation.

The spinning top

This is an instance of a object with reasonable girth, compared to its length, set spinning along its long axis. This girth and mass store rotational energy and the top can spin a long time. But the interesting thing is that the top is able to spin upright, with its point on the ground, although it would topple instantly if it were not spinning.



As shown in the picture, if the top begins to tilt to one side, which is to move downwards, this motion throws up a force that pushes the tilting axis of rotation in a horizontal way, to rotate about the vertical itself! This rotation is also a kind of ‘spin’ and this spin, in turn, generates a force to push the top upright again, and the tilt reduces. The reduced tilt reduces the horizontal motion and this again starts the vertical drop. Which increases the horizontal motion and so on.

The weather

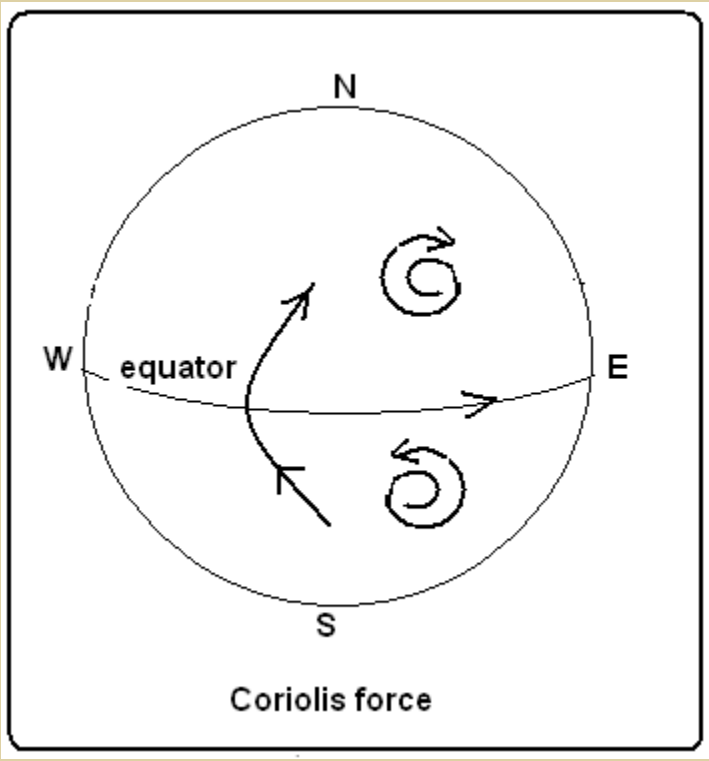
The force that seems to be pushing the top sideways or up and down is the result of how any motion begins to look different if seen from a rotating platform. The earth itself is a platform that goes right around once a day. This has an effect on winds that blow across the earth. Winds blowing towards the North Pole, from the equator, which happens in the summer, get affected by

the earth's rotation. The rotating earth moves fastest at the equator and slower as we approach the poles. The wind at the equator is also moving west to east, like the earth. But when it gets further north, the earth below is not going west to east as fast, and the wind veers towards the east. It looks like there is a force pushing the wind out to the east!

In the same way, winds blowing from the north and towards the equator start with a slow west-east motion and end up slower than the ground below. It then looks like there is a westward force and the wind veers to the west. This effect of a force on things that move within a rotating platform was discovered by a French scientist called Gustave Coriolis and the force is known as the ***Coriolis force***. It is best known for the way westward winds turn sharply to the east when they cross the equator, and which is the source of India's summer monsoon.

Cyclones

These happen when there is a spot of low pressure, usually because of local warming creating a column of rising air, and air rushes in from all sides. In the northern hemisphere, air from the north will veer to the west and the air from the south will swing to the east. This creates a circular motion of rising air and as the air rises, the circles get wider. There, we have the classic cyclone or the tornado. A more correct explanation is that in a situation of rising air columns, different layers of air could move at different speeds and in different directions. This sets up horizontal spirals of air, which the rising currents and Coriolis force soon push upwards as a cyclone.



Volcanoes

Volcanoes set up rapid upward air currents, loaded with dust, ash and lava. As volcano eruptions are rare and remote, there have been very few complete records of what happens and the theoretical base for eruptions has been rudimentary. But there have been reports that the volcanic plume rises as a rotating wheel and ends as a spinning disk, like an umbrella, with lightning flashes and waterspouts rising from the water and up to the disk. If the volcano is on the land, there may be rising spirals of dust, which are referred to as '**dust devils**'.

The one detailed report on record is by a sea Captain, who, in 1811, witnessed a volcanic spout emerging from the sea in the Azores archipelago. The captain wrote that the spout formed a plume which rotated on the water "like an horizontal wheel" and was accompanied by continuous "flashes of lightening" and a quantity of waterspouts".

More recent and more elaborate observations are by satellites that are constantly recording events on the earth. Stunning photographs of the eruption of Mount Chaiten, in southern Chille showed the volcanic plume wrapped in a sheath of lightening. Hourly pictures of Mount Pinatubo in the Philippines, taken by a satellite in 1991 showed the edges of Pinatubo's umbrella rotating about its centre.

Pinaki Chakravarty and colleagues at the University of Illinois, in a paper in the journal, ***Nature***, propose that the meteorological phenomena often observed with massive eruptions come from a 'mesocyclone' within the eruption column. "This model provides a unified explanation for these seemingly diverse events and may help scientists to better forecast and alleviate the impact of future volcanic eruptions," says the notice on the paper, in Nature.