Summer solstice, 2016

Tapping, Ken

Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/23000243
Skygazing: Astronomy through the seasons, 2016-06-21

SUMMER SOLSTICE, 2016

Ken Tapping, 21st June, 2016

At 22:34 Universal Time on 20th June, which translates to 18:34 EDT and 15:34 PDT, the Sun reaches the northernmost point in its yearly travels – the summer solstice. On this day we have the most hours of daylight and the sunrise and sunset points on the horizon are at their furthest north. On any day the Sun is highest in the sky at local (standard time) noon, but at noon on the summer solstice the Sun is the highest it gets. Actually this applies only in the Northern Hemisphere. South of the equator it is the Winter Solstice, with its lowest noontime Sun and minimum hours of daylight.

What we are seeing here is the process that gives us the seasons. The cause is the inclination of the Earth's axis. Imagine an orange with a knitting needle stuck through its centre and out the other side. The orange represents the Earth and the needle its axis of rotation.

In a tidy picture of the Solar System, one might expect all the planets to have their axes of rotation nicely perpendicular to the plane in which they orbit the Sun. However, when we look at ours and the other planets, we don't see this. The only planet that is rotating perpendicular to the orbital plane is Mercury; all the others are leaning, some at absurd angles. The values for the inclination in degrees of the planets of the Solar System are given here in brackets are Mercury (0), Venus (3), Earth (23), Mars (25), Jupiter (3), Saturn (27), Uranus (82), Neptune (28), and Pluto (60). Since these axes of rotation vary only very slowly, over tens of thousands of years, when the Earth or other planet is on one side of the Sun, its northern hemisphere is leaning toward the Sun and the southern hemisphere away, making it summer in the north and winter in the south. Then when its orbit has carried it to the other side of the Sun, the northern hemisphere is leaning away and the southern hemisphere is leaning toward the Sun, and it is now winter in the northern hemisphere and summer in the south. Uranus' axis is leaning over almost at a right angle. That planet is more or less rolling around the Sun. How could this situation arise? The answers are buried in the early history of the Solar System.

Several billion years ago, a cloud of cosmic gas and dust started to collapse. This could have been triggered by the explosion of a nearby giant star. If we take any cloud of interstellar material and take the average of how every atom and grain in the cloud is moving, we wind up with two motions: movement in a particular direction and a rotation. So as a cloud collapses it will gradually turn into a rotating disc which is moving through space at the average velocity of the cloud.

In the disc the grains of dust start to collide and stick together. As they get larger they become bigger targets, and get hit more often. Then eventually they develop a strong enough pull of gravity to pull in other chunks of material. Initially their spins will be the same as the disc, but after a few oblique impacts by other large chunks of material the embryo planets got their spins scrambled. It would be really interesting to know what sorts of collisions shifted Uranus' axis of rotation by almost a right angle.

Even after the planets had grown to almost their current sizes, there were still occasional collisions. There is evidence that something big hit the Earth, blasting debris off into space, and that this debris eventually formed the Moon. It is intriguing to consider the series of cosmic accidents that gave us the seasons we have today. If the Earth's axis had a smaller inclination we would have milder summers and winters, a larger inclination would give us hotter summers and colder winters. Imagine the seasons on Uranus!

Jupiter is descending in the west, and Mars and Saturn lie in the southern sky. Mars is the bright one; Saturn is fainter and to Mars' left. The Moon will reach Last Quarter on the 27th.

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