TEACHER RESOURCE

SCIENCE CONTENT/ CURRICULUM LINK
CYCLES OF THE MOON AND SEASONS, CALENDARS AND STARS. SHARING IDEAS AND OBSERVATIONS ABOUT MEASURING TIME.

STARDOME OBSERVATORY & PLANETARIUM
FACTS, RESOURCES AND ACTIVITIES ON...

MATARIKI WOBBLE

We celebrate New Year in summer with Santa dressed for wintery snow and ice. This date makes sense in the northern hemisphere, symbolising rebirth and the return of the Sun's plunge into winter's dark nights.

The winter solstice in New Zealand occurs in June, when the Sun stops rising and setting further north and begins to rise/set southwards, six months after the northern hemisphere winter solstice. This is when the Māori celebrate their new year.

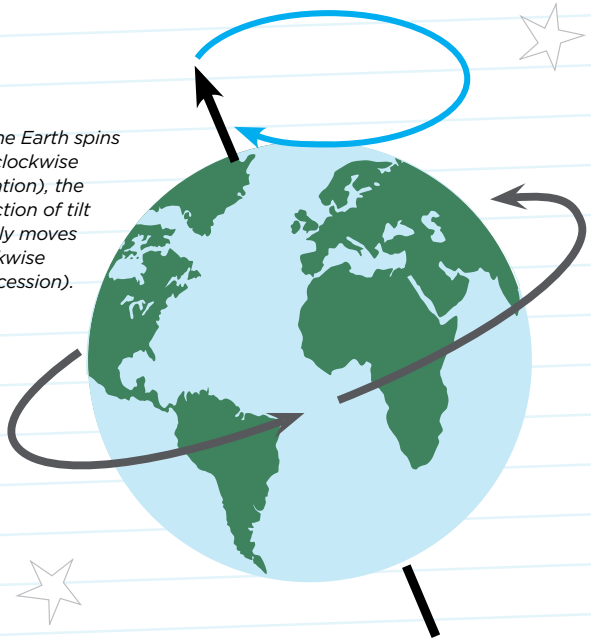
Traditional Māori time-keeping used a luni-solar calendar. Days were counted following the phases of the Moon until 12 months had passed. One cycle of Moon phases (a month from new moon to new moon, or full moon to full moon) takes 29½ days, which totals 354 days for 12 months. However, this is 11 days less than the 365 days for a complete year.

If only the Moon cycles were used, each successive year would be 11 days shorter, eventually leading to the seasons occurring out of step. To correct this, the Māori reset the lunar calendar each winter by observing the unique cluster of seven visible stars they named Matariki (Pleiades; Seven Sisters) rising immediately before dawn in early June.

This system works well, combining the cycles of the Moon and the Sun. The winter solstice currently falls in the middle of the Matariki new year season of the 4th to the 28th June.

But, there's a problem! It can't keep working this way for more than a few generations. Earth slowly wobbles as it spins, so the date Matariki rises before dawn gradually changes.

Precession also causes the position of the south celestial pole to move in a circle through the stars.



As the Earth spins anticlockwise (rotation), the direction of tilt slowly moves clockwise (precession).

This wobble is called 'precession'. It is similar to the way a spinning top or a drawing pin wobbles as it spins. The Moon and Sun (and to a lesser extent the planets) gently tug on Earth, causing a precession cycle that takes ~26,000 years.

The constellations behind the Sun gradually change, by about 1 month every 2,100 years, or 1 degree of the compass every 72 years!

In 500 years, Matariki will be rising 1 week earlier than now. A thousand years ago, about when the Māori arrived in Aotearoa, Matariki was rising two weeks later than it does now.

Half way through a complete cycle, in about 15,000AD, Matariki will be rising before sunrise 6 months earlier in mid-summer.

Our modern Gregorian calendar, with its system of leap years, keeps the seasons in step. Without further adjustments, in 10,000 years it would be out by about 10 days!

Check out these other resources...

- https://arxiv.org/ftp/arxiv/papers/0810/0810.1592.pdf
- https://en.wikipedia.org/wiki/Axial_precession

DISCUSSION POINTS

How does precession affect navigation by the stars?

Does precession occur on any other planet?

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ACTIVITY

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PRECESSION SPIN

In southern hemisphere mid-winter, Matariki rises as Earth spins just before the Sun rises. This is termed the heliacal rising of Matariki, which is currently about two weeks before winter solstice. As precession gradually turns the axis of rotation, the heliacal rising of Matariki moves backwards towards autumn and summer.

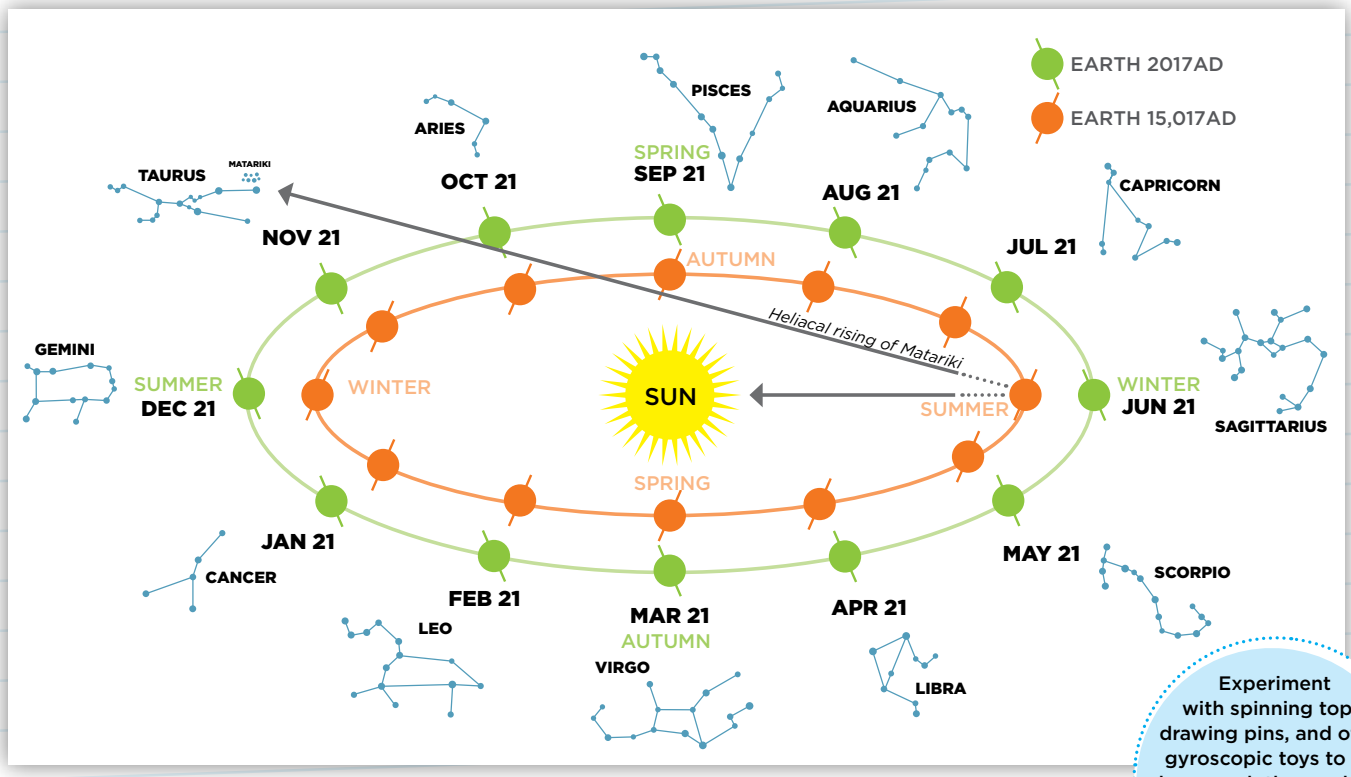
In these activities you'll be able to feel the gyroscopic forces acting on these smaller objects, mimicing the forces on Earth which is causing the gradual shift in when Matariki rises.

You'll need...

- Fidget spinner

Instructions...

- Hold a fidget spinner horizontally (vertical spin axis, like Earth) and set it spinning. When you rotate the spinner away from the initial spin axis you'll feel gyroscopic forces acting against that change in orientation, similar to the gravitational forces of the Sun, Moon and planets acting on Earth's spin axis.
- Watch gyroscopic objects in space – https://www.youtube.com/watch?v=xQb-N486mA4



Experiment with spinning tops, drawing pins, and other gyroscopic toys to see how much they wobble. How does their size and the speed they spin affect the precession?

ADVANCED

You'll need...

- Bicycle wheel
- Two handles (if the wheel axle is not big enough to hold on to)
- A spinning chair or stool

Instructions...

1. Attach the handles by screwing them onto the axle and tighten firmly
2. One student sits on the rotating chair and holds onto the wheel by the handles, while another student starts the wheel spinning
3. The sitting student tilts the spinning wheel from side to side
4. The chair should start to rotate (how fast it rotates will depend on your size, the friction of the chair and the wheel speed)

Take a photo of your activity and send it to us. We'd love to see it! education@stardome.org.nz

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