StarDate™

POLYNESIAN NIGHTS
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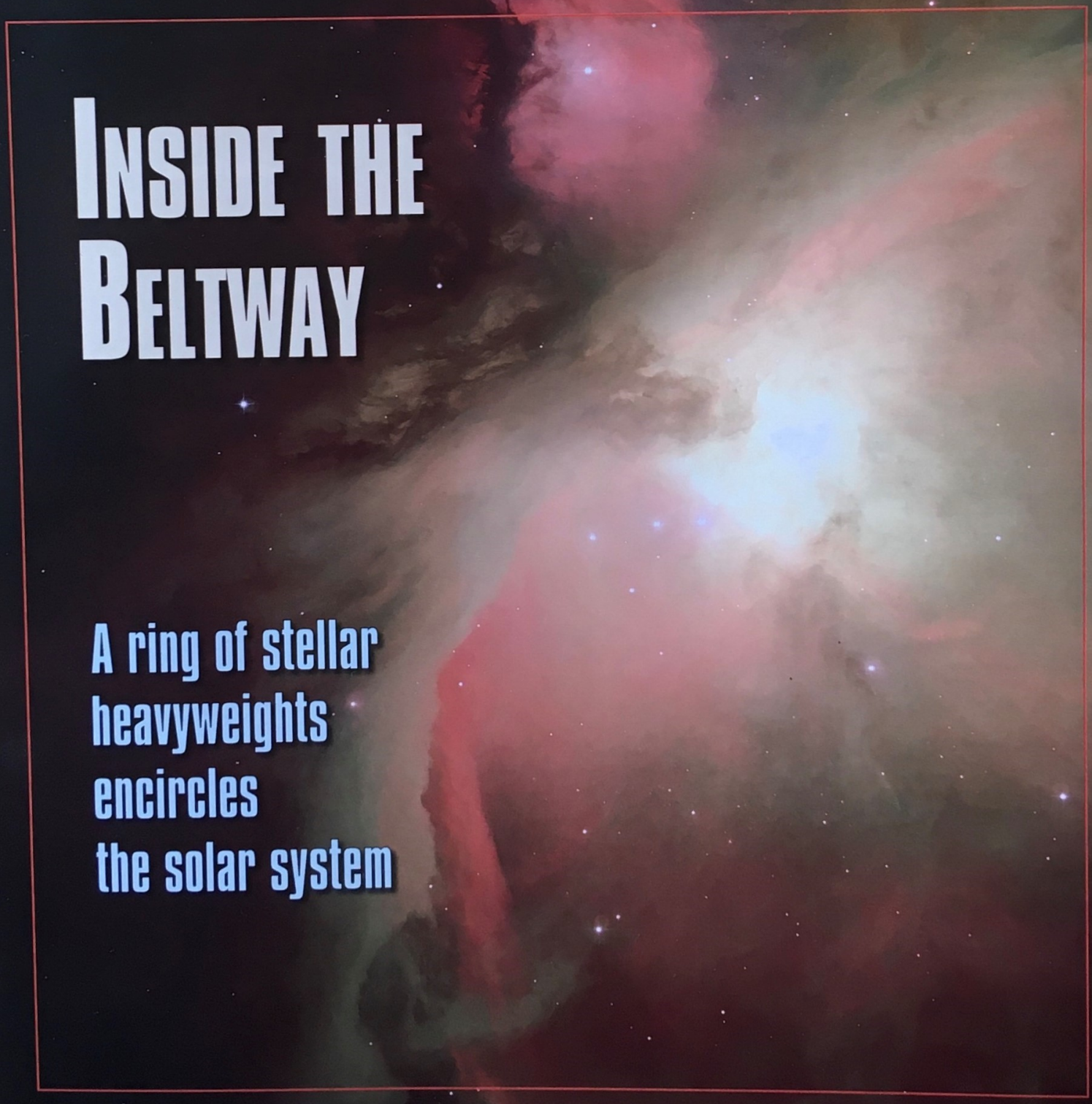


INSIDE THE BELTWAY

A ring of stellar heavyweights encircles the solar system

THE UNIVERSITY OF TEXAS AT AUSTIN McDONALD OBSERVATORY

STEERING BY THE STARS

Starting three millennia ago, Pacific Islanders used a combination of celestial navigation, knowledge of the natural world, and 'dead reckoning' to spread their culture over one-third of the globe.

By Leila Belkora

In August 1769, Captain James Cook and the crew of the Endeavour sailed south from Tahiti in search of a southern-hemisphere continent. A Tahitian chief and navigator, Tupaia, accompanied Cook on the journey. Unable to find the continent he was looking for, Cook changed course and headed for New Zealand. When Endeavour arrived two months later, Cook was astonished to find that the native Maori people spoke the same language as Tupaia. Several years later, and 3,700 nautical miles (6,850 km) to the north, Cook was just as astonished when he found that the natives of Hawaii also spoke the same language.

Cook pondered in his journal the question that was to vex future scholars for at least 200 years: "How shall we account for this Nation spreading itself over this vast ocean?" How had these island peoples, without benefit of charts, sextants, or other instruments, discovered and colonized isolated islands scattered over one-third of Earth's surface?

In the nineteenth century, Western scholars began studying the people inhabiting the thousands of islands dotting the vast Pacific Ocean between the Americas and East Asia — what is known today as Oceania. Research eventually showed that their culture originated in New Guinea and the Solomon Islands (north of Australia) around 3,000 years ago. By about A.D. 1000, using nothing more than Stone-Age tools, they had migrated north, south, and east to Hawaii, Easter Island, and New Zealand. This was around the same time that the Vikings, with their iron tools and nails, explored the North Atlantic and established a foothold in Greenland.

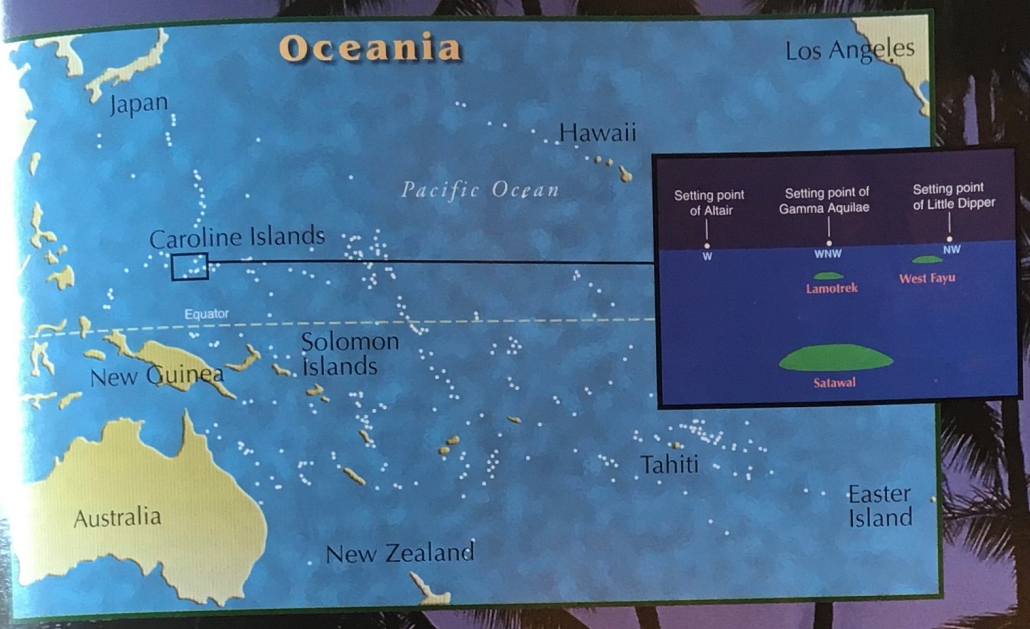
The stage was set for researchers to tackle the big question: How did the people of Oceania range over the Pacific without instruments or written maps?

In the 1960s, 70s, and 80s, Western investigators studied the remarkable wayfinding techniques that allowed Oceanic peoples to venture over millions of square miles of ocean. Their teachers, the last of the traditional navigators, were found mainly in island groups of the West Pacific, which had sustained the traditional way of life.

What they found was a system that drew on every available feature of the seascape and phenomenon of nature: winds, ocean swells, the habits of land-roosting birds, and how wind and current affects the shape of ocean waves. Foremost among these navigational aids, however, was a body of knowledge about the night sky. Navigators used particular stars to guide them from one island to another.

Training a traditional navigator began with a master navigator familiarizing his six- or seven-year-old son (or, on rare occasions, his daughter) with the stars. A navigator-in-training studied the whole sky until he could orient himself on a cloudy night, when only a few stars were visible.

Training continued both ashore and afloat



The Moon shines over Oahu. Inset: Navigating without instruments, Pacific Islanders spread their culture over the islands that dot Oceania. For example, navigation from the tiny island of Satawal to the coral atoll Lamotrek involved the setting points of stars and star groups, and a reference island (West Fayu).

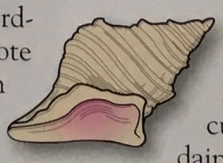
OAHU VISITORS BUREAU; TIM JONES (2)

OAHU VISITORS BUREAU

Modern Polynesians used ancient techniques to sail from Hawaii to Tahiti in the Hokule'a, a traditional double-hulled canoe.

until the navigator made his first solo voyage at around age 18; he wouldn't become a master until he was in his thirties. The navigator learned techniques associated with what we would call "dead reckoning" — paying close attention to changes in his canoe's speed and direction and tracking the distance covered. He studied the effect of islands on swell patterns, the habits of birds that fish at sea during the day and return to land at nightfall, and how winds from different directions shaped the wave crests. Most important, the navigator memorized a vast lore of sailing directions based on "star paths," or the bearings of particular stars associated with particular destinations.

Researchers from the 1908-1910 German South Seas Expedition encountered a navigator in the Caroline Islands of the West Pacific who knew the star paths "from every known place to every other known place." When transcribed, his sailing directions covered "several pages of fine print," according to Ward Goodenough, who wrote about this German expedition in his 1953 booklet, *Native Astronomy in the Central Carolines*.



An example of the wayfinding technique shows how islanders from Satawal, an island in the Carolines, would travel to Lamotrek, a coral atoll rich in fish. The navigator draws on memorized star courses, corrects for currents and winds, and mentally tracks distance covered by a system known as "etak," which involves envisioning the changing line of sight to a reference island.

In this case, the reference island is uninhabited West Fayu, 50 miles (80 km) to the northwest. West Fayu is a well-known turtle nesting site that serves as a kind of pantry for Satawal.

From Satawal, the navigator knows that Lamotrek lies in the direction of the star Gamma Aquilae as it sets (a little north of due west). West Fayu, whose location he will keep in mind as a mental aid to dead reckoning, lies in the direction of the setting Little Dipper (a little west of due north). Gamma Aquilae and the Little Dipper need not be visible at the time the navigator sets out, as he can infer their direction from the Sun or the stars that are currently visible.

As he sets out from Satawal, he does not head directly toward setting Gamma Aquilae, the true direction of Lamotrek. Instead, according to his memorized sailing directions, he goes in the direction of setting Altair (due west). After covering about 10 miles (16 km), the distance at which the home island is just visible above the horizon, the navigator looks back to see if Satawal still lies opposite setting Altair (in other words, to the east).

If so, he maintains his heading until midway through the trip, then heads north a little, in the direction of setting Gamma Aquilae. This sequence will bring him to Lamotrek under normal conditions of a wind from the northeast.

If, when he looks back toward Satawal, he finds that a current has pushed the canoe to the south, his instructions call for steering toward setting Altair until the midway point of the journey, then heading halfway between setting Altair and setting Beta Aquilae (a little south of west). A stronger current calls for yet another set of pre-ordained course corrections. A longer voyage would entail following the bearings of a succession of stars as they rose.

After a first stage of 10 to 15 miles (16 to 24 km), West Fayu lies below the North Star,

RESOURCES

Books

The Prehistoric Exploration and Colonisation of the Pacific, by Geoffrey Irwin, 1992.

The Last Navigator, by Stephen D. Thomas, 1987.

We, the Navigators, by David Lewis, 1972.

Internet

Polynesian Voyaging Society
leahi.kcc.hawaii.edu/org/pvs/

Wayfinding in the Pacific (PBS)
www.pbs.org/wayfinders/ask.html

Polaris, which marks the end of the handle of the Little Dipper. Now the navigator starts keeping an eye out for Lamotrek's birds or other signs of land in the waves and clouds. At the end of the next stage, West Fayu lies in the direction of the rising Big Dipper. During the final stage, when the navigator is looking for Lamotrek itself (whose land mass is only about three feet (one km) above sea level), West Fayu lies in the direction of rising Cassiopeia.

Throughout the trip, the navigator must concentrate mightily to monitor possible changes in wind or current direction and to visualize the changing position of his reference island.

Even on land, he cannot allow himself to relax completely. Steve Thomas studied navigation among Pacific islanders in 1983 and 1984. As he reported in his book *The Last Navigator*, a navigator named Uurupa told him, "I keep the star paths in my head wherever I go. Even now the star paths run through the place [where] we sit, but I don't think about them very hard because I am on the land and am safe. But at sea I have to think very hard."

Within the Central and South Pacific, the region known as Polynesia, navigating between islands is a little more complicated than during the typically shorter trips between the islands of the West Pacific). The basic navigational techniques are the same, but in addition, the navigator practiced "latitude sailing." The strategy is to sail to a point upwind of a destination island, turn, and search for it downwind, along a parallel of latitude. On a three-or-four week voyage from Tahiti to Hawaii, for example, the navigator would sail a course to the northeast, then turn and search downwind at a latitude of 20 degrees north.

Several different indicators can be used to estimate latitude without instruments. The altitude of Polaris above the horizon gives the latitude directly — it is 20 degrees above the horizon on Oahu, for example, which means that Oahu lies at 20 degrees north latitude. Pairs of stars may be used in a similar way to recognize specific latitudes. At the latitude of Hawaii, the angular distance between the bottom star of the Southern Cross and the horizon, six degrees, matches the angular distance between the bottom and top stars. Another indication that one had reached the latitude of Hawaii would be that the star Arcturus would pass through the zenith — the point directly overhead. At the latitude of Tahiti, however, Sirius — the brightest star in the night sky — passes directly overhead. Finally, the navigator might observe pairs of stars that set at the same time for a specific latitude. From Tahiti, Sirius and Pollux, one of the twins of Gemini, set together.

In Hawaii, a revival of traditional voyaging arts began in earnest in 1976 when the Polynesian Voyaging Society launched a double-hulled canoe, the Hokule'a (the Hawaiian name for Arcturus), on a non-instrument voyage from Hawaii to Tahiti. A navigator from the Caroline Islands named Mau Piailug guided the Hawaiian crew in the ancient way, according to the stars, Sun, Moon, and ocean swells, and using archipelagos on either side of the direct course as references. At the time, no Hawaiian knew enough wayfinding to navigate the trip without instruments, but crewmember Nainoa Thompson relates that he was inspired to study and recover the ancient ways. He learned from Piailug, and says he also spent hundreds of hours studying the night sky at the Bishop Planetarium in Honolulu. In 1980, Thompson replicated Piailug's 1976 feat, successfully guiding the Hokule'a from Hawaii to Tahiti and back, a distance of 2,400 miles (3,900 km) each way.

Since then, the Polynesian Voyaging Society and other groups have continued to build traditional voyaging canoes. They celebrate the voyaging heritage of those prehistoric peoples who so courageously sailed over Oceania, in the last major phase of human settlement of the globe.

Astronomer and science writer Leila Belkora is author of Minding the Heavens: The Story of Our Discovery of the Milky Way.

Hawaiian Star Names

The starfaring Polynesians developed a rich glossary of names for stars, planets, and other astronomical objects. Here are a few examples.

STAR
Hoku

ALTAIR
Ho'ohumu

ARCTURUS
Hoku-le'a

POLARIS
Hoku-pa'a

SIRIUS
A'a, A-iki-kau-e-lono

JUPITER
Ho'omanalo, Ikaika

MARS
Holoholo-pina'au

VENUS
Hoku-ali'i