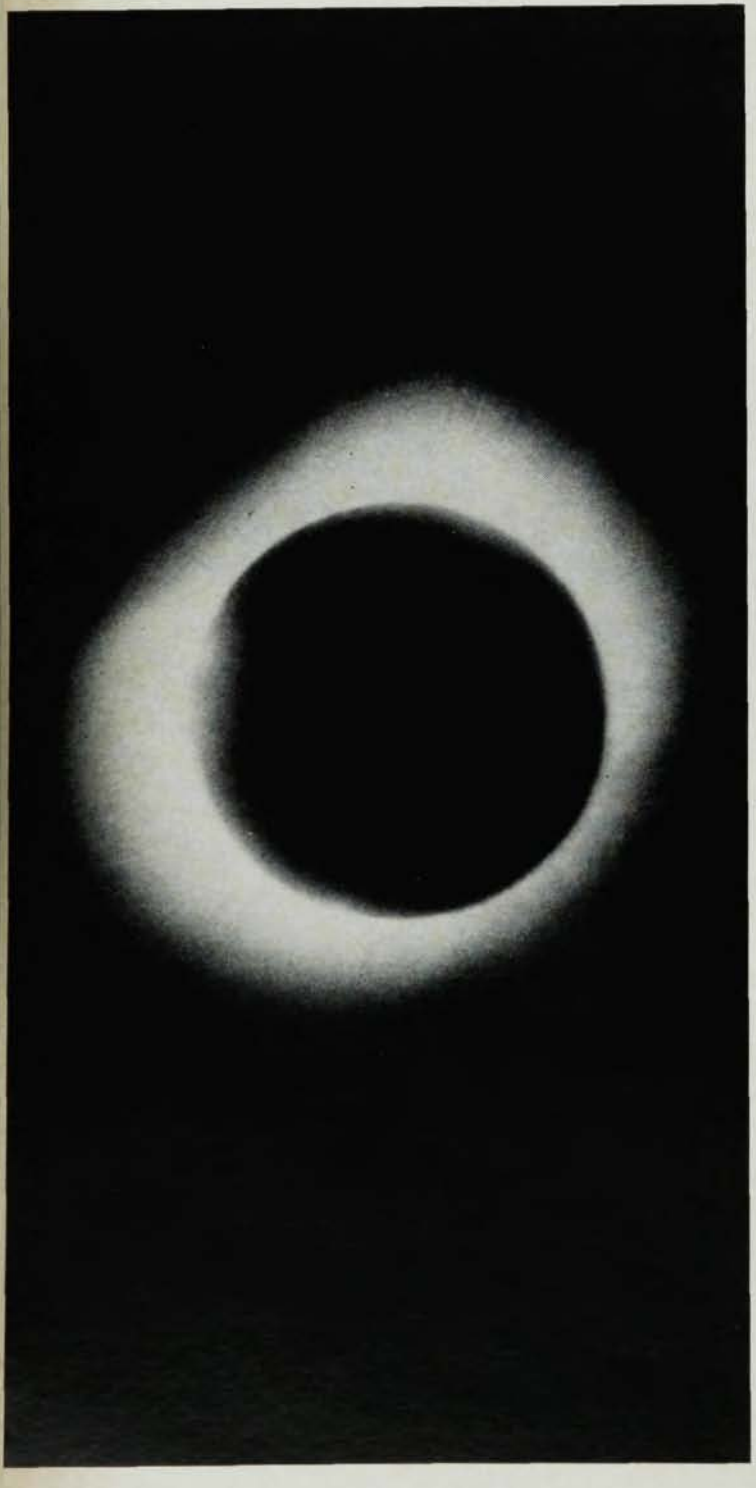
eclipse

By Serge A. Korff



Total eclipses of the sun provide astrophysicists with the same excuse for travel as physicists find in cosmic-ray investigation. Some unkind people have even referred to this as a "racket". They should attempt unloading several tons of equipment from a boat while standing in three feet of water flowing over a coral reef.

Scientific interest in eclipses is of long standing. The corona of the sun—many orders of magnitude less than scattered skylight in intensity in its outer regions—can only be studied at these rare intervals. Although there must be at least two solar eclipses a year, most of these are unusable for scientific purposes, being either annular (with a ring of photosphere showing and quite useless for coronal studies), or of very short duration, or located at some place impossible of proper access, such as parts of the Antarctic or Peking. Indeed, since the earth's surface is seven-tenths water, the probability of finding a good place on land is not great. Hence, those eclipses showing both a good duration of totality and good possible observing sites are quite in the minority and their study must be planned long in advance.

The moon's shadow is a cone and projects onto a sphere, forming a spot which is elliptical, approximating a circle near the midpoint of its travel, and of the order of fifty miles in diameter in a favorable case. This spot travels at about 1000 miles an hour. Totality may last from a few seconds to a maximum of over seven minutes (the last one that long occurred in 1937), and any eclipse over 90 seconds is considered worth observing. The one of May 30, 1965, was a good one from the point of view of duration. On our South Pacific island it lasted 212 seconds. In all history modern science has only had an hour or two to observe and study the outer parts of the corona. The so-called coronographs give specialized data about the inner parts only, and while they are important instruments there is much they cannot do.

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The total eclipse of the sun on May 30, 1965, was observed by scientific investigators from many nations from vantage points along a path sweeping across the Pacific Ocean. The present account was written by a member of the expedition to Bellingshausen, a South Pacific atoll in the Society Islands group.

This eclipse track swept over the Pacific, touching only a few tiny islands. The only two considered suitable for observing stations were Manuae in the Cook Islands, and Bellingshausen in the Society Islands group. Observing teams from many nations wanted to participate. The Cook Islands are under New Zealand administration, while Bellingshausen is French. Both governments were approached over a year ago and agreed in principle to permit expeditions. After many changes in plans, it finally worked out that the Commonwealth expedition, consisting of persons from Australia, New Zealand, Canada, and England, went to Manuae, as did part of the US, and the Japanese and Russian groups, while another part of the US and the French groups went to Bellingshausen. As the writer was on the latter island, this account will deal with that phase of the expedition.

The National Academy of Sciences, with financial assistance from the National Science Foundation, arranged for the charter of a schooner to take the entire US team of forty people from Tahiti, which is accessible by air, to the two islands. The schooner then went out to sea to become the base for balloon launchings and later returned to evacuate the personnel. The Bellingshausen party consisted of 16 persons, most of whom were astronomers or graduate students, and one cook. Groups from the Universities of Hawaii, Minnesota, and New York, and from the Joint Institute of Laboratory Astrophysics (JILA) and the High Altitude Observatory (HAO) of Boulder, Colorado, and from the Kitt Peak National Observatory formed the party. Professor Frank Orrall of the University of Hawaii was designated leader of the Bellingshausen group.

Bellingshausen was discovered by a sea captain of that name in the early eighteen-hundreds. Until recently it was uninhabited and today has a normal population of four copra gatherers, persons from Tahiti, who harvest the coconuts, dry them, and put the meat in sacks which are picked up a few times a year by collecting vessels. The island has no water, and the natives collect rainwater in a cistern. Our expedition brought its own water. The island is technically an atoll, maximum elevation about six feet above sea level, with a central lagoon and an outer reef surrounding and protecting it from the great Pacific rollers. It was promptly named "No-Women-Atoll". The central lagoon is forty-feet deep in places but because of coral heads cannot be used by sea planes. There are several passages through the island, thus making the outer annulus into a chain of islands, but no passage out through the outer reef. Consequently, everything and everybody had to be brought onto the outer reef through the breakers and there reloaded from the ship's boat into small flat-bottom boats which could make the passage across the outer reef and into the lagoon. This transfer process took place in about two feet of water that flowed rapidly in various directions as the big breakers sloshed it back and forth. The reef had many potholes, so that one might at any time find oneself in six inches of water and at the next step plunge into a six-foot hole.

The French expedition, which consisted principally of a group under Captain Halley operating an ionospheric sounding unit, occupied one of the small islets, the US group another, and the native copra gatherers a third. We had to land two tons of cement to make piers for some of the astronomical instruments. Carrying a 97-pound bag of cement through three feet of fast moving water is enough to disillusion any believer in the ease of living on idyllic tropical islands. We unloaded forty tons of supplies, including water, food, cement, tents, a complete darkroom, scientific instruments, and motor-generators for power. Once camp was established, things got much more comfortable.

The majority of the scientific experiments consisted of various spectrographic studies of the corona. Hence, several setups required a cement pier for the heliostat, a mirror driven by clockwork to produce a steady beam of sunlight, another to mount an image-forming mirror or lens, and still another for the spectrograph. After dispersion, the coronal images in the various frequencies of the principal emission lines can be scanned by photo-

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multiplier tubes and the intensities can be determined as a function of radius and angular position. A number of the experiments thus involved quite a lot of sophisticated equipment, both optical and electronic.

My own experiment was a comparatively simple photographic attempt to find motions in the corona. This problem is of interest in connection with the sudden acceleration events in which protons and other particles are accelerated to energies which sometimes may reach as high as several billion electron volts. This study required a series of photographs taken at various exposures and through various filters. Because of the rapid intensity variation with radius in the corona, any given exposure is good only over a small radial interval. To obtain meaningful photographs of all parts of the corona one must take many exposures of varying length. There is a new film with extended-range sensitivity; one camera was loaded with it.

The day of the eclipse dawned clear and at the time of totality there was only a light cirrus overcast to annoy us. The Bellingshausen group thus got a good view and was able to perform its various experiments. The Manuae group had cloud cover at eclipse time. The photograph of the eclipse reproduced here is, therefore, the only ground-based picture of the event.

It is evident that a jet airplane, flying at close to 40 000 feet, can also become a platform for observing. Such an aircraft is virtually certain of good weather and is above most of the dust and dirt of the atmosphere. Further, flying with the shadow the speed will about double the time of totality available for observation. To balance these advantages the inevitable motions of the airplane prevent any long-exposure photographs, so that the experiments which can be performed in aircraft are those that can be comparatively short exposures, depending on the acceptable tolerances. We saw the trail of a jet from the island and later learned that successful pictures of the eclipse had been obtained from it.

After the eclipse the ship-loading process had to be repeated, and the largest part of the load, including the heavy apparatus cases, was re-embarked. In the meantime a storm had come up, so that the waves at sea were much higher than during the arrival operation. To say that we got wet and that some of us were seasick is an understatement. It will of course be months before the data from the various experiments is measured and produced in final form, but in the meantime it can be said that the expedition to Bellingshausen was both interesting and successful.