jointly interested in using nuclear techniques for study and control of parasitic diseases. Some vaccines produced by the use of radiation have already brought good results in animals.

In making a workable vaccine against parasites, scientists do not have a choice between killed and weakened live organisms as in polio. Killed organisms cannot be used because they do not stimulate production of antibodies.

What has been done is to weaken the parasites with a low X-ray dosage so that some of them can be used as a vaccine. They live long enough to make the vaccinated animal immune.

For several years the University of Glasgow (Scotland) has been in the forefront in perfecting a vaccine against lungworm disease. Dr. T. A. Miller of the Burroughs Wellcome & Co. Laboratory at the university, and Prof. W. Mulligan now have produced a successful vaccine against canine hookworm, soon to be on the market.

Perfection of a human hookworm immunization cannot be expected overnight, and some scientists are dubious about the element of risk in what is still an unpredictable technique, but laboratories in this country as well as abroad are at work on various methods.

Promising results in immunization against three other parasitic diseases besides hookworm were reported.

"The radiated vaccine definitely shows protection against the malarial parasites of rodents," Dr. Tromba says. "It is reasonable to believe that the methods used to produce vaccine against parasites in animals can eventually be adapted for human beings."

Immunization against trypanosomiasis (sleeping sickness in man and nagana in cattle) was reported in Vienna. The gapeworm, a serious pest in poultry, has also been conquered.

But hookworm is one of the most damaging parasitic diseases. Each female hookworm produces about 9,000 eggs a day that pass to the outside with excreta and hatch into worms. When a bare foot contacts the worms, they burrow through the skin and enter blood vessels.

The blood carries them to the lungs, where they burrow through the delicate tissue and migrate up the windpipe, down to the esophagus and through the stomach and intestines. Here they attach themselves to the intestinal wall and begin to suck blood.

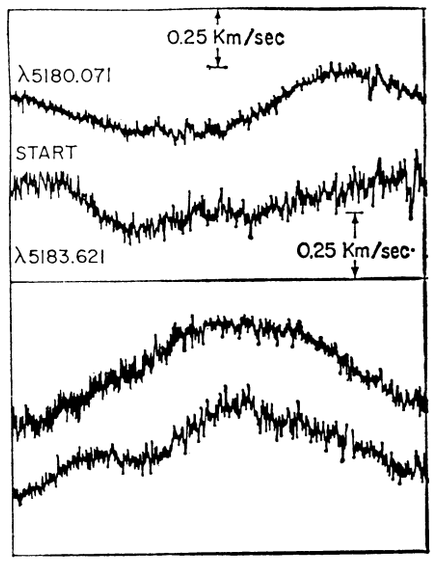
While a person seldom dies of hookworm, the parasites weaken resistance to other diseases and cause a victim to become lethargic. Treatment with drugs is possible, but the best method until now has been prevention, through sanitary toilets, wearing shoes and public education. ◈

ASTRONOMY

The Noisy Sun

In addition to pouring out an entire spectrum of radiation ranging from radio waves to cosmic rays, the sun has now been found to emit deep rumbling sound waves. The discovery may explain a long-standing astronomical puzzle.

Sound waves from the sun were so unexpected that Dr. Robert F. Howard of Mt. Wilson and Palomar Observatories first thought they were caused by instrumental or seeing defects. However, more than 250 hours of observing time, combined with analytical help from a computer and independent observation, has now convinced him that the sun radiates acoustical waves.



On the large waves, jitters of sound.

The waves are too low in frequency to be audible. They have been observed in bursts of about two minutes' duration in the hot gases of the solar photosphere, the sun's bright visible surface. Dr. Howard calls them SPO's, for short period oscillations.

The subsonic waves were detected with an instrument that records both the solar magnetic field and the vertical movements of solar gases. The motions appear as ripples, with periods of about two to three seconds, atop slower waves in the sun's atmosphere that are some 50 miles high, rising and falling at the rate of 1,000 miles an hour every five minutes.

Dr. Howard said that his observations show the ripples start at one point and spread in all directions, as sound waves should. The amplitudes of the waves are the same on all parts of the sun, whether detected toward the edge or in the center, also expected of sound waves.

There is no known connection between the large waves having a period of five minutes and the subsonic motions of two or three seconds. The mechanism that triggers the sound waves is not known, and the discovery is so recent that even speculation concerning a cause is not available.

Since the sun has acoustical waves, other stars should also have them. If they do, the sound waves may explain an old quandary—the perplexing "line broadening" observed in the spectra of many stars.

Much information about stars is contained in their spectra, which consist of the stars' light sorted into wavelengths. Superimposed on this rainbow of colors are many dark lines, each of a different wavelength and each representing a specific chemical element.

The dark lines are arranged in patterns that reveal the star's chemical composition, as well as the motions and temperatures of its gases. The puzzle has been that these lines for many stars appear to be broader than they should be, and also tend to have fuzzy edges.

A small, constant vibration in a star's atmosphere, the kind Dr. Howard found in acoustical waves on the sun, could produce this effect, thus accounting for line broadening.

Dr. Howard reported to a meeting of astronomers in Budapest on The Structure and Development of Solar Active Regions, held Sept. 5 to 8, that Dr. William C. Livingston of Kitt Peak National Observatory in Tucson had independently observed the same oscillations at the same times he had. ◈

ASTROPHYSICS

Ion Signals Across Space

Slightly less than four years ago astronomers were elated by the discovery of another chemical besides hydrogen emitting radio waves in space (SN: 11/23/63)—the hydroxyl ion, part of the water molecule.

The finding ended a long search for hydroxyl, not yet seen optically, and scientists were excited because it opened possibilities of a wide variety of new investigations of interstellar space, including charting the distribution of both hydrogen and oxygen and relating this to galactic or stellar evolution.

However, such noble goals are still distant; observations in the intervening years have continually deepened the mystery of the origin of the OH radical and the mechanism by which it emits radio waves. Little, if any, astrophysical information has resulted,