Donald Fluke, a biophysicist at the Atomic Energy Commission, Germantown, Md., scientists dismissed the idea that oxygen played an active role in radiation damage because oxygen molecules have too little energy for biologically significant chemical reactions. Then Dr. Michael Kasha of Florida State University, Tallahassee, showed that radiation changes that picture. He has demonstrated that oxygen, boosted by radiation into a higher energy state, known as a singlet excited state, can be a highly active molecule.

Most molecules exist in one of three energy states: a ground state which has zero energy, a singlet state in which the molecule is highly energetic but short-lived, and a longer-lived but less energetic triplet state. Oxygen is unusual in having two loosely paired electrons, while in most molecules all electrons are closely paired.

It is possible that radiation will boost an oxygen molecule to a singlet excited state in which the two loose electrons become closely paired. Unlike other molecules that exist in this state for short periods, the singlet excited state of oxygen is long lived, giving it time to enter into biologically significant chemical reactions.

In this state, it no longer follows its normal channels, but moves randomly within the cell where it reacts with any cellular component in its way. If that component happens to be DNA (deoxyribonucleic acid), the singlet oxygen will react with it, irreparably damaging the cell's genetic information center. This reaction can cause chromosomal mutations or can damage genetic machinery so completely that it no longer functions and the cell dies.

If you sharply reduce the oxygen content of cells, Dr. Fluke observes, you significantly reduce the extent of radiation damage. Applying the same finding in reverse, cancer researchers are experimenting with the idea of increasing the oxygen content of tumors to make them more susceptible to radiation treatment. Dr. Mark Hofferman of the National Institutes of Health, Bethesda, Md., says the therapeutic value of this approach is still questionable but experiments on mice suggest it is worth pursuing. Most solid cancers, such as lung tumors, are naturally deficient in oxygen, which may partially explain their resistance to radiation therapy.

Radiation biologists are not the only ones interested in the chemical activity of singlet excited oxygen. It is possible, Dr. Fluke says, that it is an intermediary in the chain of reactions that makes a firefly glow and that it influences skin sensitivity to light, including ordinary sunburn.

MACROMOLECULES

Super water causes flurry

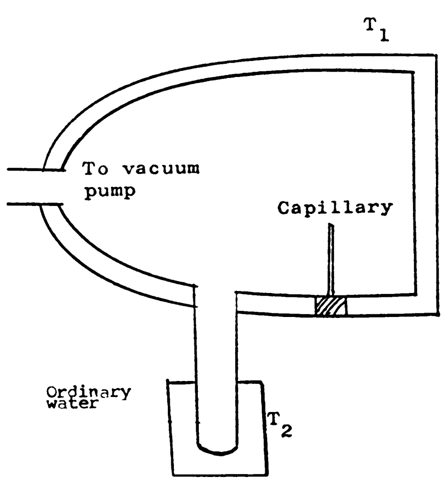
An anomalous form of water that may be a kind of macromolecule is causing serious but very quiet excitement among interested scientists.

The anomalous water, which in some measurements appears to show a high viscosity and a molecular weight about four times that of ordinary water, was first noticed by Dr. Boris V. Derjaguin, who is director of the department of surface phenomena in the Institute of Physical Chemistry of the Soviet Academy of Sciences. He was studying forces extending from solid surfaces in liquids condensed in tubes when he came across a water condensate that showed abnormal properties. His report was greeted with a good deal of skepticism but with some effort he was at last able to persuade groups at two British laboratories to check his work.

No one wanted to make a great stir, publicly, about the matter because the suggestion was hard to believe. There was and still is a large group of skeptics.

But the U.S. Navy is interested in finding out what's there. "I'm uncertain at the moment where I stand," says Harry Fox of the Office of Naval Research, but he adds that a meeting on the finding is planned for Washington, D.C., at the end of February: a small working group, "a dozen and a half observers, mainly Navy." No formal published proceedings are planned, so conferees will have an opportunity "to let their hair down" off the record.

"We've got to find out whether there is something there," says the Navy's Dr. Ralph A. Burton. "If not we'll clear the air." But he goes on to say that nobody can think of any explanation except that there is something new. People have racked their brains for explanations in terms of known materials. Peroxide mixed with water would have the viscosity but not the molecular weight, for example. "Until someone is able to give a mechanism for this it's an annoying mystery," he says.



Gear for making anomalous water.

It's annoying to theorists, whose current theories of liquids don't predict this sort of behavior. The implications can go far beyond water. Some observers feel that if water shows this anomalous state, so might other substances and a new field of research into materials with unusual properties may open up.

Early measurements seemed to show that the anomalous water had a molecular weight of 72. This is four times that of an ordinary water molecule and leads some people to suggest that the anomalous water may be some kind of polymer built of four ordinary water molecules. Other data, especially the ratio of electric charge to mass, seem to indicate, however, that the situation is more complicated, and the substance may be a mixture of several different agglomerates or macromolecules.

Anomalous water has no direct connection with the heavy water of nuclear research. Heavy water, whose molecular weight is about 20, is deuterium oxide. That is, it gets its heaviness from deuterium, a form of hydrogen with a neutron and a proton instead of a single proton in its nucleus. Anomalous water seems to be made with ordinary hydrogen.

Anomalous water is not technologically very difficult to make. The apparatus is so simple that one English boy is preparing to duplicate the experiments as a science fair project.

Needed is a clean capillary tube and a small pressure chamber to set it up in. A well attached to the vacuum chamber that serves as a source of water vapor is maintained at a temperature well below that of the main chamber. In this situation the vapor pressure in the chamber is less than the equilibrium pressure for the chamber. In spite of that, condensation occurs in the capillary tube and this condensate shows the properties of anomalous water.

The explanation, as Dr. Derjaguin sees it, is that the condensed phase grows outward from the glass walls in a manner similar to certain kinds of solid crystals. This mode of growth forms "a network of hydrogen bonds of unusual structure" in the liquid.

Though the glass tube seems to be necessary in forming anomalous water, once the substance is formed it can be taken away from the tube and will still retain its structure. It appears to be quite stable against heating, cooling and aging. There are reports that samples have been carried from Russia to Britain and still retained their anomalous properties at the end of the trip.

Anomalous water is 15 times as viscous as ordinary water and 40 percent denser. When anomalous water is mixed with ordinary water, the anomalous form separates out on chilling or is left behind when the ordinary water is boiled away, thus behaving like a separate substance that is highly soluble in ordinary water.

Some observe that the viscosity can be lowered by running the anomalous water up and down the tube several times. A similar phenomenon occurs with organic polymers that form pseudocrystalline structures that are broken up by the stresses of moving along the tube.

Normal water expands sharply as it is cooled through its freezing point. For anomalous water an analogous expansion occurs at temperatures between minus 40 and minus 60 degrees C. But on reheating, the material's behavior lags behind, and the corresponding decrease does not occur until the temperature reaches minus 30 to minus 15 degrees C. This behavior results in a difference between the temperature at which the material freezes and that at which it melts on reheating.

Observers disagree on whether anomalous water freezes. Some say it does; others says that chilling makes it form a glassy state rather than a crystalline solid.

The difficulty in determining just exactly what are the properties of anomalous water is that the capillary tube method yields amounts measured in millionths of a liter. Testing is thus very difficult.

A group under Dr. Brian Pethica at British Unilever Laboratories in Port Sunlight, England, is now trying to find a way to produce anomalous water in quantity. The group has tried condensing it in quartz powder and glass wool, but the latest report is that the problems are still to be solved.

J. L. Finney of Birkbeck College, London, who works under the direction of Dr. J. D. Bernal, has also been trying to increase production. He would like to use X-ray diffraction to study the structure of the liquid but feels he needs at least milliliter (1/1,000 liter) amounts to do it.

Very little has yet been published on the subject. Possibly the only public paper is Dr. Derjaguin's "Effect of Lyophile Surfaces on the Properties of Boundary Liquid Films," published in 1966 on page 110 of volume 42 of Discussions of the Faraday Society. There are some U.S. Navy preliminary reports, for internal consideration only.

ORBITING ASTRONOMER

Up and working at last

United States attempts to launch a satellite carrying telescopes for astronomical research have not been a tale of unrelieved success (SN: 11/16, p. 491).

The first attempt two years ago ended in a power failure. The second took on the character of a cliff-hanger as its launch date was repeatedly postponed. Toward the end it ran close to dates when its launch would have conflicted with preparations for that of Mariner Mars, which is tightly constrained in its launch window. There were fears that the Orbiting Astronomical Observatory would be bumped off the pad.

But, almost at the last minute, it went. Orbiting Astronomical Observatory A is now in orbit 480 miles up. It is working and communicating.

The OAO-A2 carries two experiments designed to observe ultraviolet light that is blocked by the earth's atmosphere. One was designed by scientists at the Smithsonian Astrophysical Observatory in Cambridge, Mass.; the other by researchers at the University of Wisconsin. Each experiment will work during alternate weeks of the flight. The satellite will be turned end over end between weeks to point the working experiment outward.

The Smithsonian experiment, called Celescope, consists of four large-aperture television cameras, each of which observes a different wavelength band. It expects to chart radiation from about 700 stars a day in these four bands. By mid-June, if the satellite lasts that long, Celescope will have catalogued up to 50,000 stars.

Instead of scanning the sky, the Wisconsin experiment will concentrate on one star at a time, averaging one per 100-minute orbit. It should obtain spectra and other information of much greater precision than could be gotten from the surface of the earth.

Up to now, it has taken 15 years and about 40 sounding rocket flights to obtain approximately three hours of ultraviolet data from some 150 stars. From the OAO-A comes twice that much information daily, and from fainter stars.

The experiments will also look at interstellar gas and dust and several planets in the solar system.

This and future Orbiting Astronomical Observatories are tools of a program to investigate astronomical objects at wavelengths unobservable from the ground (SN: 8/24, p. 188). Another satellite, Radio Astronomy Explorer A, which has been up for nearly half a year, is investigating radio bands blocked by the atmosphere. Future looks at infrared, X-rays and gamma rays are planned.

One of the most significant aspects of the OAO satellites is that they are planned not just as specific experiments, but as general observing facilities. Some three months ago, the space agency placed notices in several astronomical publications to inform interested scientists that a limited amount of time on OAO-A2 would be available to guest observers for their own researches. Almost 30 letters of interest were received from scientists at universities and in industry, of which NASA has so far replied to 19. These replies in turn have produced four formal proposals for experiments, all of which will be considered by OAO officials in mid-January. Selected experiments and observations could begin as early as the following month, assuming that OAO-A2 looks healthy enough to first give its principal researchers what they need.

Future observatories, presently scheduled for late 1969 and 1970, will make increasing amounts of time available to outside scientists. At present, OAO officials are seeking agency and budgetary approval for a Guest Observer Satellite, OAO-D, to be launched in the early 1970's, on which almost 75 percent of the observing time would be available to the astronomical community at large.

SONIC BOOM REPORT

Routes vs. sales

The boom of the supersonic transport has been the barb in most discussions of its future. The plane, as yet unborn, nevertheless has been cast as a breaker of window panes, a destroyer of national monuments and a disrupter of peace and solitude.

As a result of the advance unpopularity of the big plane's big shock wave, the Federal Aviation Administration, charged with developing the SST, long has held that the aircraft probably will be restricted to overwater routes. Maj. Gen. Jewell C. Maxwell, SST development director for the agency, says the FAA hasn't looked at a plane designed for overland flight since the early days of the program (SN: 3/16, p. 254).

Nobody connected with the program says outright that the FAA will not permit overland flights, however, nor has the agency gone very far out of its way to reassure people on the question.

Sonic boom opponents, as a result, are assuming that it is entirely possible that overland flights, if forbidden at the start, will soon be allowed. Uneasy, they reason that once the planes exist the pressure to fly cross-continental will be irresistible.

Moved by this unease and by a desire to be prepared when the time comes,