UCSD and the La Jolla Institute enter into an affiliation on behalf of the Institute's Center for the Studies of Nonlinear Dynamics. Agreement will be on a yearly basis

June 2, 1983

The University of California, San Diego and the La Jolla Institute have entered into an affiliation on behalf of the Institute's Center for the Studies of Nonlinear Dynamics (CSND).

The agreement was signed on May 31 by UCSD Chancellor Richard C. Atkinson, Dr. Adolf R. Hochstim, President of the La Jolla Institute, and Dr. Stanley M. Flatte, Director of CSND and Professor of Physics currently on leave from the University of California, Santa Cruz. The purpose of the agreement is to facilitate greater cooperation and exchange of information between UCSD and the Center.

The field of nonlinear dynamics is the study of physical and natural events which do not behave in an easily predictable manner. Weather patterns, the behavior of ocean waves, and fluctuating chemical processes are examples of nonlinear dynamics problems currently being studied at CSND.

"We welcome this opportunity to strengthen our ties with this outstanding research facility," Atkinson said of the new agreement. "I have no doubt that both the campus and the Center will benefit greatly from the improved sharing of ideas which will ultimately stem from this relationship."

"Informal ties between scientists at CSND and UCSD, particularly in physics, chemistry and oceanography, have been strong for several years," Flatte said. "This agreement will strengthen these ties and make them more effective."

The new agreement will allow UCSD graduate students to pursue their research at CSND and permit scientists from the Center to serve on their dissertation committees.

"An important contribution of the La Jolla Institute to the research activities of CSND is the organization and hosting of workshops and conferences of international scope," Flatte said.

Under terms of the agreement, scientists at the Center will be able to use university facilities such as the computer center and libraries with the same degree of access as regular UCSD faculty. Center scientists will also be given research titles at the university appropriate to their professional standing.

For more information contact: Paul Lowenberg, 452-3120

NONTECHNICAL DESCRIPTION OF WORK AT THE CENTER FOR STUDIES OF NONLINEAR DYNAMICS

Linear problems are relatively simple. For example, if a radio station doubles its power output from 10 to 20 kilowatts, it means that the signal in your radio set several miles away will get twice as strong. If a rocket engine develops twice the thrust, then the speed of the rocket after the same length of time will be twice as large. These are linear problems.

Nonlinear phenomena do not behave so simply. The most obvious nonlinear problem that confronts us every day is the weather. If the temperature drops by 10 degrees, it does not mean it will rain twice as much, or that the wind will blow twice as hard, as it would if the temperature drops 5 degrees. It may not rain at all. A simpler example, but one also not yet understood, is a dripping faucet. The faucet drips with annoying regularity at very low flow, but becomes quite random if the flow is increased. It again becomes regular and smooth at even higher rates.

At the Center for Studies of Nonlinear Dynamics (CSND), researchers, led by Director Stanley Flatte' and Associate Director Bruce J. West, are investigating a wide variety of nonlinear problems. Frank Henyey, Neil Pomphrey, Jon Wright, and George Carnevale are studying the behavior of ocean waves--both on the surface and within the ocean volume. Nonlinearity of these waves takes the form of wavelength and amplitude changes as the waves pass through each other; under the sea, the long-wavelength waves feed energy to the shorter ones, which eventually break, probably dominating the mixing processes that transport chemicals, nutrients, heat and salt throughout the ocean. One application of this work would be in understanding the heat transport in the ocean-atmosphere weather system.

Another effort at CSND involves the study of the distortion of sound and light propagation through highly variable media. Stars twinkle, radio waves from satellites are distorted by the ionosphere; radio waves from spacecraft are distorted by the solar wind; laser beams through the atmosphere are distorted by "clear air turbulence", and sound waves through the ocean are distorted by the undersea waves discussed above. These distortions are again nonlinear, as one can see by looking at the light patterns on the bottom of a swimming pool. Stanley Flatte' and Stephen Reynolds, in collaboration with Roger Dashen of the Institute for Advanced Study in Princeton, are developing a new technique for analyzing ocean acoustic fluctuations in particular.

A NONPROFIT RESEARCH INSTITUTE FOR SCIENCE AND TECHNOLOGY

Increased understanding of this nonlinear behavior will allow the design of more efficient communication systems that utilize each of the waves mentioned, but even more important scientifically, will allow the use of waves to measure the physical processes in the medium. For example, radio waves from Voyager have probed the atmospheres of Jupiter and Saturn, satellite communications have been used to analyze the ionosphere, and ocean sound waves are a highly valuable tool for probing ocean processes, from the climate-influencing general circulation to the small-scale mixing processes that may directly affect marine biology. Specifically, Dr. Flatte' and other members of CSND are developing an acoustic method for probing ocean "internal" waves beneath the surface. The experimental data for this effort is being provided by collaborators at Scripps Institution of Oceanography (SIO) (particularly Peter Worcester and Walter Munk), who are in turn working closely with several groups around the country.

Physicists and chemists have recently become much more interested in phase transitions in solid materials, mainly because of their nonlinear attributes. Materials like semiconductors or liquid crystals that are used in many practical devices exhibit nonlinear behavior that is not completely understood as yet. Similar interests in the behavior of organic and inorganic polymers apply to the manufacture and use of plastics. Some scientists at CSND are studying the triggering of phase transitions by random spontaneous variation within the material itself, rather than by an external influence of some kind. This work has been led by Bruce J. West of CSND and Katja Lindenberg of the University of California, San Diego (UCSD) Chemistry Department.

In addition to these physical, chemical, and geophysical investigations, Michael Tabor and John Weiss of CSND are involved in the abstract mathematical study of types of equations that exhibit nonlinear behavior. These equations can have unexpected practical applications, for example, in population and ecological dynamics. One recent new application has been in neurophysiology; for example, in the study of the neural control of heartbeat which can, at times, exhibit spontaneous random behavior. Motion of nonlinear systems that is apparently chaotic, may actually exhibit striking regularities. Jon Wright is working on understanding how to observe these regularities and how to use this knowledge in predicting subsequent motion.

CSND has, at any given time, a number of long-term visitors working on related topics and contributing to the stimulating atmosphere of the Center. At this time, these visitors are involved in the fields of physical oceanography, plasma physics, mathematical physics, and the mathematics of differential equations.

An important contribution of La Jolla Institute to the research activities of CSND is the organization and hosting of workshops and conferences, which are international in scope, in areas related to CSND research. Recent international conferences have covered "Predictability of Fluid Flow", which included meteorologists interested in ultimate limits on the predictability of weather; "Dynamics Days" on nonlinear dynamics, and "Problems in Unification and Supergravity" in particle physics. which included participation by, among many others, Nobel Laureates Murray Gell-Mann and Steven Weinberg.

Support for CSND comes from the La Jolla Institute and contracts from the Office of Naval Research, Defense Advanced Reseach Projects Agency, National Science Foundation, Department of Energy and the Air Force Office of Scientific Research.

(June 2, 1983)