Sociology of science found a firm foothold in the universities somewhat later than the other disciplines, and is undergoing its growth period—in numbers of graduate students and of publications—somewhat later. It also seems to have avoided the crunch in the academic marketplace which has hit the other disciplines.

Scholars who belong to the 4S group and come to its meeting would be expected to be friendly to an interdisciplinary approach to social studies of science. A few of the papers at the meeting, however, seemed to reflect more parochial preferences. And as one 4S member lamented, "Some of the younger people in the field are hung up on methodologies, they're losing perspective, forgetting that science is a social and cultural activity."

Nevertheless, the meeting gave evidence of a growing willingness to overlook differing disciplinary ideologies and assumptions. There seems to be a convergence which, in the language of the trade, is both cognitive and methodological.

Twenty-five years ago, Robert Merton in a foreward to Bernard Barber's book, *Science and the Social Order*, made a prediction that is inevitably quoted at events like the 4S meeting. Merton wrote in effect that the social studies of science would develop only when science itself came to be widely regarded as a social problem. The 4S group sees that prophecy being fulfilled, and the job of 4S to help the process along.—JOHN WALSH

Scandal in the Heavens: Renowned Astronomer Accused of Fraud

Charges of faking data to support his theories have been made against a famous astronomer whose magnum opus is known familiarly as "The Greatest."

The astronomer cannot personally answer the charges, having died not quite 2000 years ago, but at least one historian of science is prepared to do battle on his behalf.

The astronomer is Claudius Ptolemy, whose synthesis of Greek astronomical ideas was taken as the last word on the subject from the time of its composition, around A.D. 150, until the age of Copernicus some 1400 years later. Ptolemy's name became synonymous with the geocentric theory, according to which the earth rests at the center of the universe with the sun, planets, and celestial spheres rotating around it.

Ptolemy's accuser is Robert R. Newton, a member of the Applied Physics Laboratory at Johns Hopkins University. Newton considers that Ptolemy systematically invented or doctored earlier astronomers' data in order to support his own theories. "Ptolemy," he concludes, "is not the greatest astronomer of antiquity, but he is something still more unusual: He is the most successful fraud in the history of science."

Newton's charges are grave and his evidence erudite and imposing. Having checked through all the sums in the *Almagest*, he has documented his case for prosecution in various articles and a recently published book entitled *The Crime of Claudius Ptolemy*.*

But the accused has found a champion in Owen Gingerich, an astronomer and historian of science at Harvard. Gingerich agrees that Ptolemy's book, *Almagest*, contains "some remarkably fishy numbers," but he does not consider fraud to be the explanation. "When Newton and Einstein are generally considered frauds, I shall have to include Ptolemy also. Meanwhile I prefer to think of him as the greatest astronomer of antiquity," Gingerich concludes in a recent paper.

Newton's path intersected Ptolemy's when his work on satellite dynamics led him into the question of secular changes in the motions of earth and moon and from there to data collected by ancient astronomers. He noticed that Ptolemy's data disagreed both with those of other ancient astronomers and with the backward extrapolation of modern data.

Claudius Ptolemy

Systematic errors in Ptolemy's observations have been noticed before but have generally been attributed to innocent causes. For example it has been shown by J. P. Britton that if for some reason Ptolemy's watch, as it were, had been permanently half an hour slow, so that he made his observations at 12:30 p.m. when he thought it was noon, that would account for certain regular discrepancies in his data.

Discrepancies in Ptolemy's Data

But Newton sought and found another kind of explanation for Ptolemy's errors. Many of the *Almagest*'s data can be derived exactly by working out what the answer should be from Ptolemy's theory. A striking example is that Ptolemy says he observed an autumn equinox at 1400 hours on 25 September A.D. 132. This is strange because back calculation from modern tables shows that an observer at Alexandria in Egypt, Ptolemy's base of operations, should have seen the equinox at 9.9 hours on 24 September, more than a day earlier.

The discrepancy is doubly strange because Ptolemy comments that this particular observation was "one that he measured with the greatest care." Newton says he was puzzled by this emphasis, which reminded him of the behavior of students who work out the right result of a laboratory exercise from theory and insistently claim the answer as their own observation.

In this case, Ptolemy used his equinox observation to show how accurately an earlier astronomer, Hipparchus, had measured the length of the year. Hip-

*Johns Hopkins University Press, Baltimore, 1977. 412 pp. $22.50.

parchus too had measured an autumn equinox, on 27 September 146 B.C., 278 years earlier. Newton shows that if 278 times Hipparchus's estimate of a year (which is excellent but not quite right) is added to the Hipparchus equinox, the time arrived at is within minutes of the time reported by Ptolemy for his equinox. In other words, says Newton, Ptolemy must have worked backward from the result he was trying to prove instead of making an independent observation.

Newton has assiduously collected scores of similar examples in which Ptolemy's reported result is almost identical with what the Alexandrian sage wanted to prove and greatly different from what he should have observed on the basis of back calculation from contemporary data.

Few are likely to dispute Newton up to this point: certainly Gingerich does not quarrel with Newton's figures. What is more controversial is Newton's interpretation of what he has found. Newton is wholly convinced that the only explanation is deliberate fraud. He raises, only to dismiss, the possibility that Ptolemy was unknowingly deceived by a dishonest assistant. He suggests that Ptolemy was motivated by desire to be known as a great astronomer, a claim to which his theoretical competence, in Newton's view, did not entitle him. If Ptolemy's fraud was so glaring, why was it not discovered by his contemporaries? "The only answer that I can see is that there were no astronomers left who were able to make competent measurements in the critical period, say in the century following Ptolemy," Newton concludes.

Gingerich has a different explanation. In a paper of January 1977 examining Newton's thesis (as expressed in earlier writings, not his latest book), he suggests that the observations reported in the *Almagest* were just a fraction of those that Ptolemy had available to him. For pedagogical purposes, Gingerich suggests, Ptolemy selected just the data which happened to agree best with his theory. That may not conform to modern ideas of scientific reporting, but it is quite different from fraud.

Gingerich has examined various astronomical problems treated by Ptolemy and shown that although the observations he cites are few and inaccurate, the explanatory model he proposes is remarkably good. This suggests that the model must have been derived from a larger data base, with only the best fitting results being quoted in the text. It can't be ruled out that Ptolemy "simply finessed the observations," Gingerich concedes, but the purpose was for honest pedagogic reasons, not to create a scientific hoax. "I suspect that Ptolemy, like many of the brilliant theoreticians

SUNY at Albany Admits Research Violations

A second public hearing into charges that the State University of New York at Albany (SUNYA) violated federal and state regulations governing research on human beings was averted on 28 October by a final-hour settlement between the university and the New York State health department.

As part of the settlement, SUNYA officials admitted that members of the university's psychology department had violated the state's Protection of Human Subjects law in 26 named experiments (*Science*, 28 October) by:

- Not obtaining the voluntary, informed, and written consent of the research participants,
- Failing to make a fair explanation to each participant of the risks involved,
- Failing to have the experiments reviewed by an approved institutional review board, and
- Failing to supervise the experiments properly, thus "increasing the possibility of physical, psychological or social injury to the participants." Seventeen other charges were dropped because the experiments involved were "of little consequence," a health department official said.

State University officials also agreed to a 6-month period of monitoring by the health department to ensure that campuses throughout the state system are in compliance with the law, and agreed to submit a policy statement affirming that students at the school may not be compelled to participate as subjects in human research. Prior to the settlement, the university had required that introductory psychology students participate in the experiments or write a term paper—a requirement made by many universities that, according to the health department, amounts to coercion under state and federal law.

SUNYA could have been fined as much as $975,000, but Robert Whalen, the state health commissioner, assessed the university a suspended $100,000 fine that will be terminated completely if the university remains in compliance throughout the monitoring period. Roger Herdman, the state's director of public health, said that a fine probably will not be levied because "It would just go back into the state treasury, from which the university draws its funds" and because "the university has demonstrated a willingness to comply with the law in the future."

Agreement on the terms of the settlement was reached less than an hour before the start of a second public hearing on the charges, which were disclosed on 23 September. Health department officials said they had been prepared to present the testimony of several witnesses at the hearing, including that Brock Kilbourne, the former SUNYA student who prompted the investigation.

Donald Chalkley, director of the Office for Protection from Research Risks at the National Institutes of Health, said that he was satisfied by the settlement, although he will seek a separate assurance from the university that the violations will not recur. He added that he hoped that other universities "will put their houses in order" as a result of the SUNYA incident. A survey conducted in 1976 for the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, a government advisory group, indicated that between 25 and 33 percent of the universities that conduct nonfederally funded research involving human subjects do not submit the proposed research for the approval of an institutional review board recognized by the Department of Health, Education, and Welfare (HEW)—a violation of HEW rules that constituted the main charge in the SUNYA case. As a result of this affair, Chalkey said "the schools that are not in compliance should be taking a hard look at their research review procedures."—R. JEFFREY SMITH

who follow him, was profoundly convinced of the intrinsic soundness of this theory, and was perfectly willing to believe that it represented nature better than the error-marred individual observations of his day," says Gingerich.

Newton says that so far Gingerich is the only historian of science who has commented in print on his thesis. It will probably take a lot more discussion to decide the best interpretation of the problem that Newton has documented. One thing is certain: a devastating blow has been struck to the geocentric theory of the universe.—NICHOLAS WADE

Science in Europe/Moratorium Set on Antarctic Oil at October Meeting

A moratorium on oil exploration and extraction in Antarctica, and the first outlines of a convention to govern fishing in the area were the main results of the Ninth Consultative Meeting of the Antarctic Treaty in London, which ended 7 October. Both decisions represent significant developments for the 13 nations with consultative status under the treaty, who between them control the world's most remote and inhospitable continent. The meeting also gave evidence of the quickening pace of change and the need for decision if Antarctica is to be preserved as a peaceful backwater where scientists rather than politicians call the tune.

The pressures are mounting as a resource-hungry world turns its eyes on the fish, oil, and minerals that Antartica could in theory supply. According to the U.S. Geological Survey, the continental margin of Western Antarctica could contain as much as 45 billion barrels of discoverable oil and 115 trillion cubic feet of natural gas. Fish provide an even more tempting resource; stocks of a shrimp-like crustacean known as krill are so vast that they could represent a doubling of the world catch.

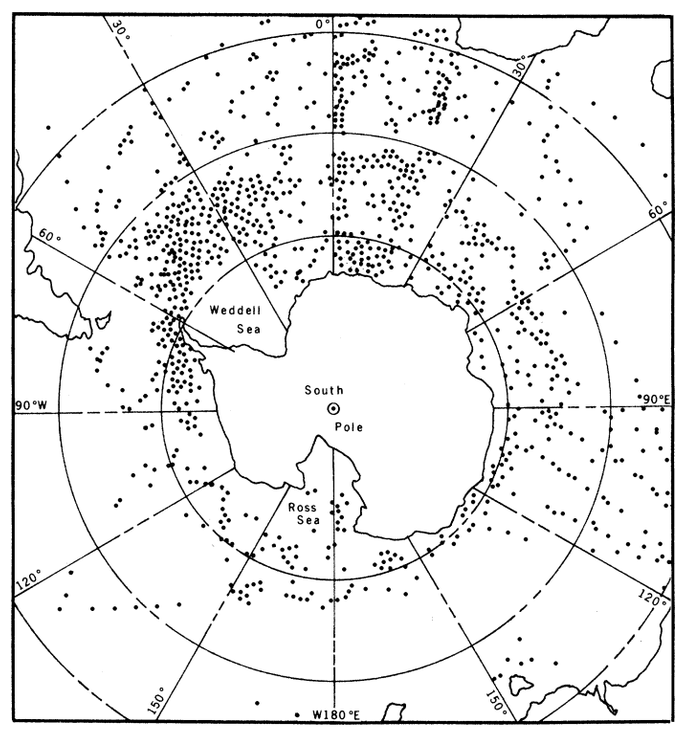
Drilling for oil is probably still years in the future, but exploitation of the krill has already begun. Soviet and Japanese vessels land between them something like 20,000 tons of krill a year, to be marketed frozen as is shrimp, as krill paté, or in such manufactured products as shrimp-flavored butter and cheese spread. West Germany, Taiwan, and Chile are also showing interest in the krill fisheries. In addition, the Antarctic waters contain other more conventional seafoods such as crab, lobster, cod, and hake. As the northern fisheries come under increasing control and coastal states extend their fishing limits, the relatively unpoliced oceans around Antarctica become more attractive.

It is something of a historical accident that the 13 nations of the Antarctic Treaty come to be responsible for managing this resource. The Antarctic Treaty was established after the success of the International Geophysical Year, 1957–1958, which showed that nations were able to work together in programs of scientific research. The original 12 "consultative parties" to the treaty were simply those 12 countries which had been collaborating in the Antarctic—Argentina, Australia, Belgium, Britain, Chile, France, Japan, New Zealand, Norway, South Africa, the United States, and the U.S.S.R. In July of this year, Poland became the 13th member.

That the treaty has held together so well is evidence of the relative unimportance of Antarctica until recent years. The parties by no means represent a cross section of the world community, with only two developing countries, and there are wide differences of attitude among the parties, some of whom claim parts of Antarctica as their own territory. Others, including the United States, the U.S.S.R., and Japan recognize no territorial claims, and have none of their own. To make matters even more complicated, three of the claims (those of Argentina, Britain, and Chile) actually overlap.

The Antarctic Treaty has worked because it sets aside the territorial disputes. In this case, at least, sweeping the problems under the rug has paid off handsomely in 25 years of peaceful scientific cooperation. But once matters of natural resources are discussed, the issue of sovereignty emerges again and becomes more difficult to solve. If there are resources to be exploited, who owns them?

It was this issue that caused the greatest difficulty at the London meeting. De-



Distribution of potential krill fisheries around the Antarctic Continent. Krill fishing has only begun, but the resource may be twice the world's catch. [Map adapted by Eleanor Warner]