moon itself, for example. Even after the six Apollo landings and a series of unmanned Soviet probes, its origin and evolution is as obscure as ever. Researchers are not even sure if the moon has a metallic core. The Lunar Geochemical Orbiter, scheduled for launch in 1991, will map the broad-scale surface composition. But it will need to be followed up by seismic networks, heat-flow measurements, and in situ chemical analysis.

In the same vein, the relatively pristine surface of the moon has preserved a record of early solar system. Solar wind and solar flare particles trapped in the lunar surface layer, for example, can trace changes in solar activity over the past 4 billion years.

As a platform for space astronomy, the moon offers three advantages. First, radio telescopes on the far side would be shielded from terrestrial radio emissions, which would allow for observations at the theoretical limits of sensitivity. Second, the moon provides a solid, seismically stable, high-vacuum platform for interferometric arrays; a lunar optical array, for example, might resolve astronomical details about a million times finer than those seen from the earth. Finally, the moon lies beyond the earth's radiation belts, which gives it a low-background-radiation environment for studying such things as cosmic rays, the solar wind plasma, cosmic neutrinos, and even gravitational radiation.

As a source of raw materials in space, the moon is attractive for the simple reason that lifting an object into orbit from its surface takes roughly 1/20 to 1/30 as much energy as launching it from the surface of the earth. A prime example is liquid oxygen, which will be much in demand as a propellant for hydrogen-oxygen rockets such as the Centaur upper stage or the orbital transfer vehicle. It happens that oxygen is abundant in the silicate rocks of the moon and could be extracted using readily available solar power.

In conclusion, the participants in the symposium cheerfully admitted that the whole idea of a lunar base is highly speculative—but then, how does any new idea get started? Indeed, several enthusiasts called the meeting a landmark. More realistically, however, it was a trial balloon, an attempt by lunar base proponents to get the attention of the Administration, the media, and most especially, NASA headquarters.

In that they probably succeeded. It remains to be seen if they can build a compelling political case for the moon.

—**M. Mitchell Waldrop**

Obstacles to Arms Control in Space

Continued pursuit of a comprehensive ballistic missile defense, as outlined in President Reagan's "Star Wars" plan, will bar any meaningful limitation on antisatellite weapons, according to a report prepared recently for the Arms Control and Disarmament Agency (ACDA). Conversely, the report says, a continuing effort to develop and deploy antisatellite weapons will seriously erode existing limitations on ballistic missile defenses.

The report, written under contract by William Durch, a former ACDA official who is presently a research fellow at Harvard University,* indicates that the Reagan Administration will face some difficult choices when it next confronts the Soviet Union in arms negotiations. Last summer, the Soviets indicated that one of their first priorities in any arms control talks would be to halt the testing and development of satellite killers by the United States (*Science*, 10 August, p. 601). Durch makes it clear, however, that such an agreement will be meaningless unless restrictions are also placed on the testing and development of ballistic missile defenses.

The reason, he explains, is that the technology needed for ballistic missile defense (BMD) and for an antisatellite weapon (ASAT) is similar. Under an existing BMD treaty, for example, either country can develop and deploy a limited number of weapons capable of intercepting ballistic missiles in midflight. Due to the overlap in technology, these could also be used to attack low-altitude satellites. At a recent defense conference, Major General Eugene Fox, the manager of the Army's BMD program, agreed that "without a doubt, there is a technical capability to do it." Last summer, the United States successfully tested such a weapon against a missile over the Pacific Ocean.

More sophisticated space-based BMD systems, of the type envisioned by Reagan, would "automatically" provide extensive ASAT capabilities, Durch says. The reason is that satellites, which are less numerous and travel in more or less predictable orbits at relatively low speed, will never be more challenging targets than ballistic missiles, and will therefore be vulnerable to any BMD weapons deployed within range.

Conversely, weapons designed primarily as ASAT's can also provide limited BMD capability. Fixed and mobile ground-based lasers, for example, cannot be tested in a BMD "mode," under an existing BMD treaty. However, they can be tested in an ASAT mode, and there is some overlap between the two. Such tests "could generate considerable uncertainty with respect to . . . treaty compliance," Durch writes. Similarly, a space-based system composed of multiple projectiles that home in the heat signature of satellites could "provide valuable data" for a BMD system aimed at missiles. And a space-based laser and particle beam system designed primarily to attack satellites "could be quite valuable to the design and development of space-based BMD."

Durch writes that "there is, in short, a two-way synergy . . . that could only be interrupted by prohibitions on space-testing for both." Although the report makes no explicit recommendations, Durch lists a number of reasons why such prohibitions would be sensible. One is that the United States intends to deploy a manned space station within the next decade, and to fly an increasing number of space shuttle missions, which will be vulnerable to ASAT attack. Another is that "ASAT will be a growth field for spending," with successful tests spawning a costly new competition with the Soviet Union. A third is that "it will be more difficult to roll back ASAT capabilities a decade hence." If one takes these into account, as well as what Durch describes as the minimal utility of ASAT's in a conflict with the Soviets, then the benefits of arms control seem clear, he says.

Henry Cooper, the director of ACDA's strategic programs bureau, says that he agrees with the report's conclusions about the overlap in BMD and ASAT technologies.—**R. Jeffrey Smith**

*Durch, who also worked at the Center for Naval Analyses from 1973 to 1978, is solely responsible for the study's conclusions. But he had advice from Ashton Carter, an assistant director of the Center for Science and International Affairs at Harvard University, who formerly worked at the Defense Department's systems analysis office; Donald Hafner, a former adviser to the National Security Council on ASAT matters, who now teaches at Boston College; Stephen Meyer, a political scientist at MIT who directs a working group in Soviet security studies; Paul Stares, a research fellow at the Brookings Institution; and Philip O'Neill, Jr., a lawyer in Boston.