

Joel Primack and Space Nuclear Reactor Arms Control 1987-1992

In addition to leading research in cosmology, astrophysics and particle physics, Joel Primack has long been a leader in science and technology policy. In fall 1987, Joel attended a meeting on US-USSR arms control in Washington, DC, at Federation of American Scientists (FAS) chairman Frank von Hippel's invitation. Joel discussed space nuclear reactor arms issues with Roald Sagdeev, who was then head of the Soviet Space Research Institute and a top advisor to USSR President Gorbachev. The US launched the first orbiting nuclear reactor in 1965, and the USSR had subsequently launched about 35 of them, mostly to power low-orbiting radar satellites that the US called Radar Ocean Reconnaissance Satellites, or RORSATS, that tracked the US navy. The US was developing antisatellite weapons partly to shoot down the RORSATS, and the US was also developing "Star Wars" antimissile weapons to be powered by larger nuclear reactors. Joel and Roald agreed that it would be in both the US and USSR interest to propose a ban on further launches of orbiting nuclear reactors, and they agreed to announce such a proposal in a press conference on Roald's next visit to the US in May 1988. They did this at the National Press Club on May 13, 1988. By coincidence, an English boys school that routinely tracked satellites had announced the same day that the latest RORSAT, Cosmos 1900, appeared to be malfunctioning. Both the danger that this RORSAT might fall to earth and our proposal to ban orbiting reactors were reported in May 14 articles in the *New York Times* by Bill Broad and in the *Washington Post* by Kathy Sawyer. Most of the RORSATS had ejected their nuclear reactor cores to 850 km orbits before reentry, but two earlier RORSATS had fallen back to earth with their cores, one in 1978 that radioactively contaminated a strip of northern Canada 300 km long by 100 km wide requiring extensive cleanup, and another in 1983 that fell into the ocean.

Joel initiated and co-led with Frank von Hippel and Roald Sagdeev a research project on space nuclear reactors, the FAS/Committee of Soviet Scientists (CSS) Space Reactor Arms Control study group. The participants included Joel's wife Nancy E. Abrams, an international lawyer, and also Steven Aftergood, David W. Hafemeister, Daniel O. Hirsch, Robert Mozley, Yuri V. Petrov, Philip Pinto, Oleg Prilutsky, Sanislav N. Rodionov, and Alexander I. Schlyachter.

An early fruit of this research was a calculation by Joel and Philip Pinto of the gamma radiation and positron flux from orbiting reactors. (Pinto was then a graduate student at UCSC working on supernova theory, and he is now a professor of astronomy at the University of Arizona.) This was the basis for an article, coauthored with Oleg Prilutsky, "Detection of Space Reactors by their Gamma-Ray and Positron Emissions," *Science and Global Security*, **1**, 129-146 (1989), showing that a ban on space nuclear reactors could easily be verified using the tremendous fluxes of these radiations. In July 1988 Joel presented a talk on orbiting reactors in a workshop on Protecting the Space Environment at Cambridge University, and a joint colloquium with David Hafemeister "Verifying a Ban on Orbiting Reactors" at the Stanford Center for Arms Control and International Security. On July 25, 1988, Joel was organizer and chairman of a FAS Congressional Briefing on Space Nuclear Power at the Russell Senate Office Building.

From September 5 to 9, 1988, Joel led the US team working with the CSS members of Space Reactor Arms Control study group at the Soviet Space Research Institute in Moscow. In addition to finishing the article with Pinto and Prilutsky mentioned above, we prepared other articles that were published in the inaugural volume of *Science and Global Security*, including Joel R. Primack, Nancy E. Abrams, Steven Aftergood, David W. Hafemeister, Daniel O. Hirsch, Robert Mozley, Oleg F. Prilutsky, Stanislav N. Rodionov, and Roald Sagdeev, "Space Reactor Arms Control: OVERVIEW," *Science and Global Security, Vol. 1, pp. 59-82*; reprinted in *Science and Global Security, Preview Issue, pp. 49-72*. We also drafted a major article on "Nuclear Power in Space," which was eventually published in *Scientific American*, June 1991, 42-47, coauthored by Steven Aftergood, David Hafemeister, Oleg Prelutsky, Joel, and Stanislav Rodianov.

Joel also led a meeting of the US team with a group at the Foreign Ministry of the USSR led by a deputy foreign minister, in which we emphasized the danger of RORSAT reactors producing radioactive contamination and the desirability of avoiding a nuclear reactor arms race. The deputy foreign minister assured us that there would be no new RORSAT launches for at least two years. In fact, there were no further orbiting nuclear reactors launched, and the USSR ceased to exist in 1991. Dan Hirsch, who had participated in the meetings at the Soviet Space Research Institute and the meeting at the Soviet Foreign Ministry, flew back to Washington, D.C., where he reported on these meetings in the USSR, and he and Steve Aftergood presented testimony on Cosmos 1900 and arguments against orbiting reactors including those being developed for the US missile defense program.

While we were in Moscow, Joel and Nancy met with a group of "refuseniks" (Jewish scientists who had been refused permission to emigrate, and were subsequently fired from their jobs), and we were subsequently able to arrange for two of these families to emigrate with help from Senator Ted Kennedy, with whom both Joel and Nancy had previously worked. Joel also gave lectures in Moscow about his astrophysics research and initiated research programs with two Russian astrophysicists, Lev Kofman and Anatoly Klypin, that subsequently led to many significant research papers. Anatoly Klypin, now a professor of astronomy at New Mexico State University, has been one of Joel's main research partners for the past 25 years; they have published over 60 papers together.

In November 1988, at a conference at UCLA on Gamma Ray Astronomy, in addition to presenting a talk reviewing his own research on detecting dark matter, Joel gave an additional talk "Space Reactors: Signals and Backgrounds" that was published in *Nuclear Physics B (Proc. Suppl.)* **10B**, 172-180 (1989). When Joel explained that space nuclear reactors in orbit would emit gamma rays and positrons, Stephen White, a member of the audience, responded that his group's balloon-borne detectors must have seen these reactors. This was apparently the first public discussion of such detections. FAS also initiated a Freedom of Information request for information about RORSAT radiations detected by US satellites that led to declassification of these detections by the US Solar Maximum Mission gamma-ray satellite program, which was very much welcomed by scientists connected with this program. A result was the publication in *Science* magazine

of several articles: Erich Rieger et al., “Man-Made Transients Observed by the Gamma-Ray Spectrometer on the Solar Maximum Mission Satellite, *Science* **244**, 441-444; G. H. Share et al., “Geomagnetic Origin for Transient Particle Events from Nuclear-Reactor Powered Satellites,” *Science* **244**, 444-448; E. W. Hones and P. R. Higbie, “Distribution and Detection of Positrons from an Orbiting Nuclear Reactor,” *Science* **244**, 448-451; Terrence J. O’Neill et al., “Observations of Nuclear Reactors on Satellites with a Balloon-Borne Gamma-Ray Telescope,” *Science* **244**, 451-454. Joel wrote an invited Perspective accompanying these articles, “Gamma-Ray Observations of Orbiting Nuclear Reactors,” *Science* **244**, 407-408 (April 1989).

Joel wrote a piece, "FORUM: Let's Ban Nuclear Reactors from Orbit," *Technology Review*, Vol. 92, No. 4 (May/June 1989), pp. 27-8; letter: "More on Reactors in Orbit", *Technology Review*, Vol. 93, No. 2 (February/March 1990), p. 7. In 1989-91, Joel also gave many public talks about space nuclear reactors and more general space debris issues, including an invited talk “Banning Orbiting Reactors” at the March 1989 AAAS annual meeting in San Francisco; Hebrew University Physics Colloquium: "Protecting the Space Environment"; invited talk on Space Reactor Arms Control at the Physicians for Social Responsibility Annual Meeting; UCSB Physics Colloquium "Space Reactors, Gamma-Ray Astronomy, and SDI Arms Control"; invited talk on US-Soviet Cooperative Studies on Space Reactor Arms Control at the UC Institute on Global Conflict and Cooperation Natural Sciences and Engineering Conference at UC Davis; Berkeley Physics Department Colloquium: “Space Reactors, Gamma-ray Astronomy, and Arms Control”; College of William and Mary Physics Department Colloquium: “Space Reactors, Gamma-ray Astronomy, and Arms Control”. Joel organized and chaired the symposium on "Protecting the Space Environment" at the 1991 annual meeting of the APS, including an invited talk: “Protecting the Space Environment: Overview”.

In 1992, Joel gave an invited lecture at the MacArthur Foundation Symposium Preserving the Space Environment, University of Chicago; invited lecture: “Protecting the Space Environment for Science”, and he prepared a written version for the book from this conference edited by John A. Simpson, *Preservation of Near-Earth Space for Future Generations* (1994).

In April 2002 Joel and Nancy Abrams lectured on “Star Wars Forever? – A Cosmic Perspective,” at the UNESCO Conference on Science and the Search for Meaning. Nancy and Joel were interviewed by the BBC and their opinion piece “Star Wars Forever?,” appeared in the British magazine *Astronomy Now*, June 2002, p. 90. In May 2002 Joel presented the Keynote Lecture at the Conference on Future Security in Space, New Place (near Southampton, England), “Debris and Future Space Activities,” organized by the Monterey Institute of International Studies Center for Nonproliferation Studies and by the University of Southampton's Mountbatten Centre. This was published in the proceedings, CNS Occasional Papers, *Future Security in Space: Commercial, Military, and Arms Control Trade-Offs*, James Clay Moltz, ed., Center for Nonproliferation Studies (ISBN 1-885350-040X, 2002), pp. 18-22. On this trip Joel also gave a public lecture at New College, Oxford, “Space Debris and Star Wars.” Joel’s article “Pelted by paint, downed by debris: Missile defenses put valuable satellites at even

greater risk,” appeared in *The Bulletin of the Atomic Scientists*, September 2002.