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Romaška et le pouvoir de la conversion : l'internationalisme nucléaire soviétique et les satellites à propulsion nucléaire

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FABIAN LÜSCHER

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According to the electronic encyclopedia of Rosatom, the institutional heir of the Soviet nuclear ministry (Ministerstvo Srednogo Mashinostroenie; *Sredmash*), an American scientist almost fainted during a Soviet presentation at the Third Geneva Conference on the Peaceful Uses of Atomic Energy (PUAE) in 1964.[1] Nikolai N. Ponomarev-Stepnoi had just announced the "launch" of a nuclear reactor which produced electricity by direct thermoelectric conversion – a technology suited to use in spaceflight. Lost in translation, the scientist in the audience misinterpreted Ponomarev-Stepnoi's announcement, thinking that the Soviet Union had already shot a working nuclear reactor into outer space.[2] Even The *New York Times*' correspondent at the conference was quite confused about the actual meaning of this "launch." He wrote that the reactor-converter "[...] is cylindrical, suggesting that it is to fit inside a rocket. It is not clear whether one of them has yet been placed in orbit."[3] To the relief of the Americans in the audience, Romashka, as the Soviet reactor-converter was known, actually never left Earth, even though it attracted international attention and created considerable confusion in the mid-1960s, since it appeared to be the world's first working project to bring together nuclear and space technology.

1. Andrei A. Akatov and Iurii S. Koriakovskii, *Rosatom: Istoriia i sovremennost´. Entsiklopediia atomnoi otrasli, 2015* [Rosatom: past and present. Encyclopedia of the nuclear industry], Chapter 6: "Issledovatel´skie reaktory [Research reactors]," online : <http://edu.strana-rosatom.ru/glava-6-issledovatelskie-reaktoryi/#glava-6-issledovatelskie-reaktoryi> (04.07.2019).

2. Ibid.

3. Walter Sullivan, "Soviet Building 2 Atom Iceships," *Special to The New York Times*, 6 September 1964.

Cahiers du Monde russe, 60/2-3, Avril-septembre 2019, p. 397-416.

In the present article, Romashka serves as an example with which to discuss the fabric and functioning of Soviet nuclear internationalism – a concept introduced here as an addition to related concepts such as "nuclear diplomacy."[4] I discuss how and why the reactor-converter entered the international arena while other technologies did not. Considering Gabrielle Hecht's assumptions about the power of nuclear things, I emphasize the particularities of the Romashka project at the intersection of the Soviet nuclear and space enterprises.[5] I further argue that the peculiar combination of nuclear and space technology was the main reason for the project's international career, as Romashka's promotors could bring to the fore its different assets according to policy requirements; Romashka was at once both an experimental device for prospective uses in outer space and a prototype nuclear reactor.

Historians of science have long argued that scientists' work is usually shaped by two conflicting factors – the intrinsically international character of scientific knowledge production versus the fact that scientific working conditions are mostly defined by the state in which it is conducted.[6] To analyze and historicize these conflicting factors, the pivotal questions concern how and why knowledge moves across borders, as emphasized most recently by John Krige.[7] East–West cooperation – and competition – during the Cold War is a particularly attractive object for historians and continues to keep them busy.[8] As David Reynolds summarized, it was especially the "crucial element of big government" – the state becoming the

4. Most recently, Maria Rentetzi advocated a "diplomatic turn in history of sciences": Maria Rentetzi, "A Diplomatic Turn in History of Science," *History of Science Society Newsletter*, 47, 1 (2018): 12–14; recent contributions to the discussion of the science diplomacy concept include: Charles Weiss, "How Do Science and Technology Affect International Affairs?" *Minerva*, 53, 4 (2015): 411–430; Birte Fähnrich, "Science Diplomacy. Investigating the Perspective of Scholars on Politics–Science Collaboration in International Affairs", *Public Understanding of Science*, 26, 6 (2017): 688–703; O.S. Nagornaia, "Kul′turnaia diplomatiia nauchnogo sotrudnichestva i obrazovatel′nykh obmenov v epokhu Kholodnoi voiny [Cultural diplomacy of scientific cooperation and educational exchanges in the Cold War era]," in O.S. Nagornaia, ed., *Sovetskaia kul'turnaia diplomatiia v usloviiakh Kholodnoi voiny, 1945–1989* [Soviet cultural diplomacy in the context of the Cold War, 1945–1989] (M.: Rosspen, 2018), 96–121.

5. Gabrielle Hecht, "The Power of Nuclear Things," *Technology and Culture*, 51, 1 (2010): 1–30.

6. For an overview see: Alexander Keynan, "The Political Impact of Scientific Cooperation on Nations in Conflict. An Overview," *Annals of the New York Academy of Sciences*, 866, 1 (1998): 1–54.

7. John Krige, "Introduction," in John Krige, ed., *How Knowledge Moves: Writing the Transnational History of Science and Technology* (Chicago: The University of Chicago Press, 2019): 1–31, here: 3–4.

8. Relevant publications include: Klaus Gestwa and Stefan Rohdewald, eds., "Kooperation trotz Konfrontation. Wissenschaft und Technik im Kalten Krieg," *Osteuropa*, 59, 10 (2009) [special issue]; John Krige and Kai-Henrik Barth, eds., *Science Technology, and International Affairs*, *Osiris*, 21, 1, (2006) [special issue]; Naomi Oreskes and John Krige, *Science and Technology in the Global Cold War* (Cambridge: MIT Press, 2014); Stefan Guth, Fabian Lüscher and Julia Richers, "Nuclear Technopolitics in the Soviet Union and Beyond," *Jahrbücher für Geschichte Osteuropas*, 66, 1 (2018) [special issue]; new approaches are explored by Maria Rentetzi and her team in the project "Nuclear Diplomacies. Their Past, Present and Future" <https://nucleardiplomacies.weebly.com> (22.06.2019) as well as in the research project "Kooperation und Konkurrenz in den Wissenschaften" at the Ludwig-Maximilians-Universität in Munich <https://www.kooperation-und-konkurrenz.geschichte.uni-muenchen.de> (22.06.2019).

"pre-eminent patron of scientific research" – which made science and technology a particularly important field of superpower rivalry.[9] The manifold uses of harnessed nuclear energy and the new frontiers opened by spaceflight were the two main areas of competition in the 1950s and 1960s. Both fields were affected by what Asif Siddiqi called a "rhetorical tension":[10] nuclear power and space projects were emblematic for the Soviet Union's image and, at the same time, vulnerable aspects of national security and were thus kept as secret as possible. While space technology was shrouded in almost complete secrecy, the CPSU gave the proponents of nuclear energy's so-called peaceful uses some leeway to share knowledge in the wake of the U.S. Atoms for Peace campaign.[11] This policy aimed to promote Soviet prowess in high technology, which was meant to impress states of the global south with the power of socialist development.[12] Furthermore, it was thought that travel to international conferences would help Soviet scientists gather useful knowledge from abroad and obtain a clearer picture of the level Soviet science had attained in comparison to the state of the art in their field.

In order to analyze the history of Soviet space nuclear power technology against the background of nuclear internationalism, this article considers Soviet sources as well as archival holdings and published documents of international organizations. While edited archival sources such as the multivolume *Atomnyi Proekt SSSR* are indispensable for any study on Soviet nuclear history, they are, of course, far from comprehensive.[13] Accordingly, much of the information about Romashka's international career had to be drawn from accounts written by scientists who were actually involved in the project themselves or from *festschriften* written in honor of the masterminds behind the reactor-converter. Both genres tend to tell affirmative histories about the Soviet space nuclear power program and are accordingly treated as repositories of lexical information and not as critical historiographical analyses.

9. David Reynolds, "Science, Technology, and the Cold War," in Melvyn P. Leffler and Odd Arne Westad, eds., *The Cambridge History of the Cold War*, vol. 3, (Cambridge: Cambridge University Press, 2010): 378–399, here: 379.

10. Asif Siddiqi, "Cosmic Contradictions. Popular Enthusiasm and Secrecy in the Soviet Space Program," in James T. Andrews and Asif A. Siddiqi, eds., *Into the Cosmos: Space Exploration and Soviet Culture* (Pittsburgh: University of Pittsburgh Press, 2011), 47–76, here: 49.

11. On the intentions behind the Atoms for Peace Speech see for example: Kenneth Alan Osgood, *Total Cold War: Eisenhower's Secret Propaganda Battle at Home and Abroad* (Lawrence: University Press of Kansas, 2006), 153–180; Ira Chernus, *Eisenhower's Atoms for Peace* (College Station: Texas A&M University Press, 2002); Mara Drogan, "The Nuclear Imperative: Atoms for Peace and the Development of U.S. Policy on Exporting Nuclear Power, 1953-1955," *Diplomatic History*, 40, 5 (2016): 948–974; Mara Drogan, *Atoms for Peace, US Foreign Policy and the Globalization of Nuclear Technology, 1953–1960*. Ph.D. diss., (New York: 2011).

12. Soviet nuclear energy policy in its international entanglement, including bilateral cooperation and work in intergovernmental organizations, has recently been discussed by: David Holloway, "The Soviet Union and the Creation of the International Atomic Energy Agency," *Cold War History*, 16, 2 (2016): 177–193; Fabian Lüscher, "The Nuclear Spirit of Geneva. Boundary-Crossing Relationships of Soviet Atomic Scientists after 1955," *Jahrbücher für Geschichte Osteuropas*, 66, 1 (2018): 20–44.

13. L.D. Riabev et al., eds., *Atomnyi Proekt SSSR: Dokumenty i materialy* [The atomic project of the USSR. Documents and materials], vol. 1–3, (M.: Nauka, 1998–2009).

Wherever possible, archival evidence is used to provide a more complete picture of Soviet space nuclear power's international history.

In the first part of this article, I outline some conceptual reflections before discussing the history of space nuclear power and its international implications. Here, I touch upon the guiding question behind this case study: how did Romashka end up in the international limelight in the early 1960s, a time when theoretically "secrecy pervaded every single aspect of the Soviet space program"?[14] I argue that the key to understanding Romashka's international appearance lies in the fact that it was as much a nuclear thing as it was a space device.[15] While space technology remained completely secret throughout the 1960s, the Soviet reaction to the U.S. Atoms for Peace campaign opened some windows of opportunity – however regulated and limited – to bring nuclear projects to the attention of an international public. Even though Romashka grew out of the Soviet endeavor to maintain the lead in the space race, it always remained a flightless prototype nuclear reactor-converter which never left the Kurchatov Institute – the Soviet Union's most powerful center of nuclear science and technology.[16] On the international stage, Romashka was presented as a nuclear thing whose significance for space flight was simultaneously unclear and obvious. Romashka's exceptional position at the intersection of the space and nuclear programs provided its creators with an exceptional opportunity to make the small reactor-converter a showpiece of Soviet nuclear internationalism.

Soviet nuclear internationalism: Conceptual reflections

Inspired by Akria Iriye, internationalism is thought of as a set of fundamental ideas, processes and phenomena, led by the conviction that certain interests and goals should be pursued by working together across state borders.[17] Accordingly, "nuclear internationalism" goes beyond the mere negotiation of arms control or arms reduction.[18] It is rather used as an integrative analytical term facilitating understanding

14. Siddiqi, "Cosmic Contradictions," 48.

15. The argument according to which the "nuclearity" of certain things is subject to historical changes and negotiation and interpretation is pursued most convincingly by Hecht: "The Power of Nuclear Things."

16. Kurchatov's Institute changed its name several times. First it was called "Lab. No. 2" until 4 April 1949, then "Laboratoriia izmeritel´nykh priborov Akademii nauk SSSR" (LIPAN), then, in 1956, "Institut atomnoi energii Akademii nauk SSSR" (IAE) and from 1960 onwards "Institut atomnoi energii imeni I.V. Kurchatova" (KIAE).

17. Akira Iriye, *Global Community: The Role of International Organizations in the Making of the Contemporary World* (Berkeley: University of California Press, 2004) 9–10; Akira Iriye, *Cultural Internationalism and World Order* (Baltimore: The Johns Hopkins University Press, 1997).

18. An example of the use of the term "Nuclear Internationalism" in reference to belligerent uses of nuclear energy only is: Jonathan R. Hunt, *Into the Bargain: The Triumph and Tragedy of Nuclear Internationalism during the Mid-Cold War, 1958–1970,* Ph.D. diss. (Austin: 2013); Paul Josephson speaks instead of "internationalism in nuclear physics", referring to the First Geneva Conference on the Peaceful Uses of Atomic Energy in 1955, albeit without giving a definition of the term "internationalism" in this context: Paul R. Josephson, *Red Atom: Russia's*

of a broad range of subjects. The proposed term includes the international negotiation of everything nuclear, with a special emphasis on negotiations in multilateral settings. Boundaries between state and non-state actors, however, are often blurred, again most recently noted by John Krige.[19] To grasp international flows of scientific knowledge, it is important to focus on the historical actors themselves and to consider their dual role as promoters of scientific exchange and as science diplomats.[20] The integrative perspective subsumed under the concept of nuclear internationalism helps us overcome a problem highlighted by Karena Kalmbach in a recent survey of state-of-the art research in the field of nuclear history: "[…] [N]uclear power and nuclear weapons are still very much treated as two separate entities […]."[21] Space nuclear power is a good example of the inseparability of "warlike" and "peaceful" nuclear history, as space nuclear power units could supply energy for both reconnaissance and meteorological satellites. Taking an integrative perspective furthermore implies that the internationalization of science and the development of Soviet foreign politics regarding all uses of nuclear energy are tackled as highly interrelated fields that cannot be examined in isolation from each other.

Other analytical concepts, such as "nuclear diplomacy," a derivative of "science diplomacy," focusing specifically on nuclear science and technology, emphasize state-to-state relations and view bargainers primarily as state representatives.[22] "Nuclear internationalism" instead stresses the importance of allegedly shared values as a central point of reference in networks of scientists with different ideological and socio-political backgrounds. It was through contact with peers that many scientists came to see themselves as members of an international community, most appropriately described by Peter Haas's concept of epistemic communities.[23] The argument of shared values among scientists helped Soviet scientists claim authority in science-related policy making. Accordingly, epistemic communities are understood as an important point of reference within Soviet nuclear internationalism. They are not understood as stable groups held together by an unchanging set of shared values, but as an idea that was important for the ways Soviet nuclear specialists saw both themselves and their role in society.[24]

Nuclear Power Program from Stalin to Today (New York: W.H. Freeman, 2000), 174; on the changing attitude towards the internationalization of science after Stalin's death see: Paul R. Josephson, "Atomic-Powered Communism: Nuclear Culture in the Postwar USSR", *Slavic Review*, 55, 2 (1996): 297–324, here: 301–304.

19. Krige, "Introduction", 7.

20. Nagornaia, "Kul´turnaia diplomatiia," 99.

21. Karena Kalmbach, "Revisiting the Nuclear Age. State of the Art Research in Nuclear History," in *Neue Politische Literatur*, 62, 1 (2017): 49–69, here: 50.

22. Rentetzi, "Diplomatic Turn," 12–14.

23. Peter Haas, "Introduction: Epistemic Communities and International Policy Coordination", *International Organization* 46, 1 (1992), 1–35.

24. On the power of scientific universalism as self-representation see: Geert J. Somsen: "A History of Universalism: Conceptions of the Internationality of Science from the Enlightenment to the Cold War," *Minerva*, 46, 3 (2008), 361–379, here: 362.

"Soviet nuclear internationalism" means the ideas, strategies and conduct of different Soviet actors and actor groups in international networks, organizations, at conferences or in policy advisory bodies. It is not to be understood as a historically static concept, but as a "moving target," the result of constant negotiation between different stakeholders and flexible adaption to shifts in domestic and international political constellations. Some of the defining characteristics of Soviet nuclear internationalism in the 1960s and beyond can be described as expressions of the revolutionary internationalism revived in the Khrushchev years: many of the fundamental ideas leading to broader scientific and technological exchange and cooperation were inspired by the intention to constrain "Western imperialism," "facilitate decolonization" and promote the "global spread of communism."[25] The promotion of these guidelines remained paramount for Soviet delegations at international conferences but did not make it impossible to pursue other agendas, such as the setting up of knowledge exchange and networking.

Research and development in space nuclear power are suitable examples with which to discuss different aspects of Soviet nuclear internationalism. Romashka and some of its follow-up projects were the subject of broad and different international discussions and its chief organizer became an influential expert and policy advisor – not least in his capacity as head of the Soviet Pugwash committee.[26] Further, the international career of Romashka and the people behind it demonstrate how security concerns, secrecy obligations and imperatives of state propaganda decided the destiny of border-crossing movements of knowledge, people and technology.

Romashka: A power unit for the space program?

In the Soviet Union, the idea to develop and apply nuclear power units for propulsion arose in the early 1950s, not long after completion of the initial bomb project, which had received undivided attention. Nuclear propulsion projects can roughly be divided into three spheres: terrestrial, maritime and aerial.[27] The Soviet state invested heavily in producing civilian nuclear firsts – not least because the CPSU attributed great value to positive publicity for non-military scientific-technological achievements. In 1954, the world's first nuclear power station was launched near Moscow, feeding the local grid with a rather insignificant amount of electricity but

25. On Khrushchev's revolutionary internationalism see: Vladislav M. Zubok, *A Failed Empire: The Soviet Union in the Cold War from Stalin to Gorbachev* (Chapel Hill: University of North Carolina Press, 2007), 143.

26. Matthew Evangelista, *Unarmed Forces: The Transnational Movement to End the Cold War* (Ithaca – London: Cornell University Press, 1999), 35–39; Fabian Lüscher, "Party, Peers, Publicity. Overlapping Loyalties in Early Soviet Pugwash, 1955–1960," in Alison Kraft and Carola Sachse, eds., *Science, (Anti-)Communism and Diplomacy: The Pugwash Conferences on Science and World Affairs in the Early Cold War* (Leiden: Brill, 2020): 121–155.

27. N.N. Ponomarev-Stepnoi, "Iadernaia energiia v letatel′nykh apparatakh [Nuclear energy in aircraft]," in N.S. Khlopkin, ed., *A.P. Aleksandrov. Dokumenty i vospominaniia* [A.P. Aleksandrov. Documents and memories] (M.: IzdAT, 2003), 195–201, here: 195–196.

helping the Soviet regime claim prowess in nuclear power technology.[28] In 1959, the icebreaker "Lenin" became the first nuclear-powered surface vessel in human history.[29] Even though the broadly discussed nuclear powered aircraft project never surpassed its experimental stage, the preparatory work in this field ultimately led to the development of yet another field of application for nuclear power: various types of space devices needed reliable power sources to accomplish their missions.[30] Due to its extreme compactness, nuclear fuel had a couple of significant advantages over chemical fuel, especially for unmanned spacecraft, where no heavy shielding was needed to protect people from radiation. Given the overall enthusiasm about nuclear power at the dawn of the cosmic era in the late 1950s and early 1960s, it is not surprising that the superpowers encouraged research and development in the field of space nuclear power.

By then, different kinds of nuclear power generators were already in use or in operational testing. While terrestrial nuclear power plants and even the much smaller units designed to power submarines relied on steam turbines, space devices were sought to work without any moving parts. This goal was to be achieved by direct thermoelectric conversion; this approach promised to make use of the unparalleled advantages of nuclear energy without the need to employ large, heavy and moving instruments to convert heat into electricity.

In the United States, efforts to harness nuclear energy by direct thermoelectric conversion first bore fruit in 1959, when President Dwight D. Eisenhower proudly announced the world's first nuclear battery, *SNAP-3* (System for Nuclear Auxiliary Power).[31] Two years later, in 1961, the United States started to use radioisotope

28. On the role of Obninsk as a showpiece of the Soviet atomic program's peaceful intentions see: Roman Khandozhko, "Dissidence behind the Nuclear Shield? The Obninsk Atomic Research Centre and the Infrastructure of Dissent in the Late Soviet Union," *Jahrbücher für Geschichte Osteuropas*, 66, 1 (2018): 65–92; Galina Orlova, "Kontakty tret´ei stepeni. Zametki o vitrinnoi nauke [Encounters of the third kind. Notes on science on display]," *Novoe literaturnoe obozrenie*, 4 (2014); Hiroshi Ichikawa, "Obninsk, 1955. The World's First Nuclear Power Plant and 'The Atomic Diplomacy' by Soviet Scientists," *Historia Scientiarum*, 26, 1 (2016), 25–41.

29. On the relevance of the icebreaker "Lenin" in public discourses see: Josephson, *Red Atom*, 120–127; Sonja D. Schmid, "Shaping the Soviet Experience of the Atomic Age. Nuclear Topics in *Ogonyok*, 1945–1965", in Dick van Lente, ed., *The Nuclear Age in Popular Media: A Transnational History, 1945–1965* (New York: Palgrave Macmillan, 2012): 19–51, here: 30–33.

30. On the history of the Soviet nuclear airplane see: N.N. Ponomarev-Stepnoi, N.E. Kukharkin and V.A. Usov, "Iadernye ustanovki dlia energetiki i promyshlennosti i atomnye letatel´nye apparaty [Nuclear power and industrial installations and atomic aircraft]," in N.N. Ponomarev-Stepnoi, ed., *Unikal'nye razrabotki i eksperimental'naia baza Kurchatovskogo instituta* [Unique research and the experimental base of the Kurchatov Institute] (M.: IzdAT, 2008), 12–45; V.N. Orlov and M.V. Orlova, *General'nyi konstruktor N.D. Kuznetsov i ego OKB* [Chief designer N.D. Kuznetsov and his Design Office] (Samara: Volga Dizain, 2011), 80–86; Josephson, *Red Atom*, 130.

31. Richard G. Hewlett and Jack M. Holl, *Atoms for Peace and War: 1953–1962, Eisenhower and the Atomic Energy Commission* (Berkeley: University of California Press, 1989), 518–519; "Text of White House Statement on Atom Generator", *New York Times* (17.01.1959): 3; SNAP-3 was first used to power an artificial satellite on 29 June 1961. Within the SNAP-Series, odd numbers stood for nuclear batteries, while even numbers were assigned to reactor-projects.

thermoelectric generators (RTG) to power artificial satellites in outer space. These "batteries" were the first devices to make use of nuclear power in space. They relied on thermoelectric conversion to generate electricity, but were not based on fission. Instead they used the heat given off by the natural decay of radioisotopes to produce electricity.

In the Soviet space program, nuclear power was explicitly mentioned as one promising idea for further research and development in a CPSU resolution on the future of Soviet space flight in June 1960.[32] The most promising Soviet nuclear space power project was based on an actual fission reactor. The decision to build such an experimental reactor was taken by the Soviet government based on a suggestion by the Kurchatov Atomic Energy Institute (KIAE) in 1961.[33] Most likely, this decision was influenced by the successful use of radioisotope generators aboard satellites launched by the United States that same year. In 1961, several institutes and many scientists and engineers began working on what would soon be called the Romashka project.[34] Mikhail D. Millionshchikov was appointed head of the project. By the time the project started, he could draw on extensive experience in the Soviet Union's military nuclear program, which he had entered in 1949 – the year of the first Soviet atom bomb test.

In 1938, Millionshchikov had defended his *aspirantura* dissertation at the Moscow Aviation Institute (*Moskovskii aviatsionnyi institut*; MAI), and continued to work there while he prepared his *doktorantura*. After the evacuation of the MAI during the war and after having held different teaching and research positions in Alma-Ata and Kuibishev (today Samara), Millionshchikov defended his *doktorantura* dissertation at the Institute of Mechanics of the Soviet Academy of Sciences in 1945. Two years later, still working at the Academy of Sciences, Millionshchikov entered the VKP (b), the predecessor of the CPSU. In 1949, Igor′ V. Kurchatov (1903–1960) invited him to his institute, where he worked for the rest of his life – even in the capacity of a deputy director from 1960 onwards. His scientific background in both the theoretical and applied physics of the movements of gas streams and of jet engines for airplanes were very welcome at Kurchatov's institute.

32. Iurii M. Baturin, ed., *Sovetskaia kosmicheskaia initsiativa v gosudarstvennykh dokumentakh, 1946–1964* [The soviet space program in State documents, 1946–1964] (M.: RTSoft, 2008); A.V. Zrodnikov, L.I. Kudinova and Iu.V. Frolov, "Leipunskii A.I.", in A.V. Zrodnikov, ed., *Fiziko-Energeticheskii institut. Letopis' v sud'bakh* [The Institute of physics and power engineering. A chronicle through life stories] (Obninsk, 2006), 16–27, here: 25–26.

33. N.E. Kukharkin, N.N. Ponomarev-Stepnoi and V.A. Usov, *Kosmicheskaia iadernaia energetika. Iadernye reaktory s termoelektricheskim i termoemissionnym preobrazovaniem – "Romashka" i "Enisei"* [Space nuclear energy. 'Romashka' and 'Enisei' nuclear reactors with thermoelectric and thermionic conversion] (M.: IzdAT, 2012), 19–20.

34. Most likely, Romashka received its name due to the arrangement of its power elements. The shape of the reactor-converters cross-section is actually reminiscent of a chamomile blossom: Francois Kertesz, Language of Nuclear Science (Oak Ridge, 1968) online: <https://www.osti.gov/servlets/purl/4825109> (09 July 2019), 17.

From 1950 onwards, he had led the development of axial compressors – a central tool in the process of uranium enrichment by gaseous diffusion.[35] Shortly afterwards, he became involved in research concerned with gas centrifuges – another method of uranium enrichment, then believed to be pivotal for the Soviet nuclear weapons program.[36] At the same time, he was part of a group of scientists who were working on the detection of nuclear explosions at long distance. In 1950, Millionshchikov became a member of the powerful Scientific-Technical Council of the Soviet atomic administration.[37] In short, Millionshchikov was an important member of the Kurchatov Institute with access to highly sensitive knowledge as early as 1950. Like many other future leaders and public persons of Soviet nuclear internationalism, he gained his initial experience of nuclear engineering in the bomb project, developing and planning equipment to speed up the production of enriched uranium. Much of his research was directly linked to the military atomic program and was thus top secret – some of it remains classified to this day.

Millionshchikov was a distinguished scientist whose organizational skills were in great demand and who was also fluent in English and French.[38] In 1953, the year of Beriia's fall, in the wake of which Sredmash was founded, and Eisenhower's Atoms for Peace speech, he was elected a corresponding member of the Soviet Academy of Sciences. He soon became a member of numerous scientific advisory bodies and later a deputy director of the Kurchatov Institute and the head of Sredmash's section for aviation and rocket energy installations (Section No. 10).[39] In these capacities, he was entrusted to head the construction of the small but very complex reactor-converter which would soon become a showpiece of Soviet prowess in nuclear engineering and a symbol of promise for nuclear-powered space exploration. Romashka

35. 14 February 1950, "Postanovlenie Soveta Ministrov SSSR 'O plane nauchno-issledovatel′skikh, proektnykh, konstruktorskikh i opytnykh rabot na 1950 god' [Resolution of the Council of Ministers of the USSR 'On the plan regarding research, design, and experimental work in the year 1950'],” in Riabev et al., eds., *Atomnyi proekt SSSR*, t. 2, kn. 5, (M.: Nauka, 2005): 153–160, here: 156.

36. On the history of the gas centrifuge method for uranium enrichment see John Krige, "Hybrid Knowledge. The Transnational Co-Production of the Gas Centrifuge for Uranium Enrichment," *The British Journal for the History of Science*, 45, 3 (2012): 337–357; William Burr, "The 'Labors of Atlas, Sisyphus, or Hercules'? US Gas-Centrifuge Policy and Diplomacy, 1954–60," *The International History Review*, 37, 3 (2015): 431–457; William Burr, "To 'Keep the Genie Bottled Up'. U.S. Diplomacy, Nuclear Proliferation, and Gas Centrifuge Technology, 1962–1972," *Journal of Cold War Studies*, 19, 2 (2017): 115–157.

37. 14 February 1950, "Postanovlenie SM SSSR 'O sostave sektsii Nauchno-tekhnicheskogo soveta Pervogo glavnogo upravleniia pri Sovete Ministrov SSSR' [Resolution of the Council of Ministers of the USSR 'On the members of the sections of the scientific-technical Council of the First Main Administration under the Council of Ministers of the USSR'],” in Riabev et al., eds., *Atomnyi proekt SSSR*, t. 2, kn. 5, 161–164.

38. A.D. Shveitser, *Glazami perevodchika. Iz vospominanii* [Through the eyes of a translator. Memories] (M.: P. Valent, 2012), 83.

39. Galina Orlova, "Fiziki-iadershchiki v bor′be za pravo na kosmos. Apokrif [Nuclear physicists in the struggle for the right to space]," in *Vestnik PNIPU*, 2 (2018): 108–126, here: 117; A.K. Kruglov, *Shtab Atomproma* [The staff of the atomic industry] (M.: CNIIatominform, 1998), 253.

was supposed to combine the vast power of fission with light and immovable thermoelectric conversion units and would thus become a prototype for nuclear space power devices with much higher energy output than the above-mentioned radioisotope generators. It was a pioneering project which, if successful, would be a potential atomic first. Against the background of the superpowers' space race, the project received some prominent support from Sergej P. Korolev, the leading Soviet rocket designer. He had visited the Kurchatov Institute in January 1964, not long before the first test of Romashka.[40] Korolev was enthusiastic about the promises of nuclear power in space and supported the intensification of the efforts around Romashka. Not least thanks to support of this kind, which helped to guarantee constant state sponsoring and thanks to the efforts made by numerous institutes throughout the country, Romashka could successfully be test-started in August 1964.

The small reactor worked on fast neutrons, providing heat of up to almost 2,000° C.[41] Including the surrounding neutron reflector, the reactor was about one meter high and weighed 265 kg. Its active zone was cylindrical, almost 35 centimeters high and 25 centimeters in diameter. Inside, a total of 49 kg of uranium-235 ensured the constant fission process.[42] After completion, Romashka had an electrical energy output of about 470 watts. It worked for over 20 months without interruption and provided a lot of experimental data which were later used to build similar power units, including reactor-converters for actual use in spaceflight missions. The successful experimental launch of Romashka in August 1964 was quickly brought to public attention. On 31 August 1964, the third UN Geneva Conference on the Peaceful Uses of Atomic Energy opened its gates. There, the Soviet delegation announced to the world the launch of the non-flying experimental reactor-converter.[43]

Beyond space? Romashka in Geneva

In comparison to its predecessors, the 1964 conference was much more dedicated to the industrial application of nuclear energy than to groundbreaking scientific-technological inventions. There were two exceptions to this rule – two fields which had not been discussed on an international level before: nuclear-powered seawater desalination and direct conversion of fission power to electrical energy.[44]

40. Ponomarev-Stepnoi, "Iadernaia energiia v letatel′nykh apparatakh," 200.

41. Josephson, *Red Atom*, 133.

42. A lot of additional technical data are provided in: Kukharkin, Ponomarev-Stepnoi and Usov, *Kosmicheskaia iadernaia energetika*, 21–30.

43. M.D. Millionshchikov et al., "Vysokotemperaturnyi reaktor-preobrazovatel′ 'Romashka' [High-temperature reactor-converter 'Romashka']," *Atomnaia Energiia*, 17, 5 (1964): 329–335.

44. On nuclear powered desalination in the Soviet Union see: Stefan Guth, "Oasis of the Future. The Nuclear City of Shevchenko/Aqtau, 1959–2019," *Jahrbücher für Geschichte Osteuropas*, 66, 1 (2018): 93–123.

The responsibility for the program of all Geneva Conferences lay with a group of experts, the Scientific Advisory Committee of the UN Secretary General (UNSAC). Most of its members had a scientific-technological background but most of them qualified by virtue of extensive experience in administrative work in their country's nuclear energy programs. Vasilii S. Emel′ianov had replaced Dmitrii V. Skobel′tsyn in May 1957 as the Soviet member of this committee and was thus responsible for representing Soviet interests in the planning of the 1964 conference.[45] From the UNSAC records it becomes clear that Emel′ianov was instructed to put thermoelectric conversion on the agenda for the 1964 conference. As early as the first preliminary discussions on a possible third Geneva Conference in 1959 – two years before the Romashka project actually started – Emel′ianov stressed that "any achievements made at the industrial level and likely to interest all countries – for instance, the direct conversion of heat into electricity" – should be extensively covered in a possible next conference.[46] When the British expert, William Penney, claimed three years later that "contributions should be of a practical nature" and "[f]usion, high energy physics, direct conversion and isotopes should be only fringe topics," Emel′ianov firmly disagreed, maintaining his stance on the importance of thermoelectric conversion for the upcoming 1964 conference.[47] There are many reasons for the disagreement between Penney and Emel´ianov about the role thermoelectric conversion should play in Geneva. Most importantly, the British and Soviet nuclear energy programs of the early 1960s headed in different directions. While the British AEC had ambitious plans for a quick and extensive installation of commercial nuclear reactors, the Soviet energy industry mostly relied on fossil fuels. The first Soviet industrial scale nuclear power plant would not be connected to the grid until 1964. In Great Britain, twelve commercial reactors were already in use in late 1962.[48] Accordingly, the British expert was more interested in international exchange about topics relevant to the development of an actual nuclear energy industry, while the Soviet representative saw greater benefit in discussing innovative projects – at best even linked with the much-admired Soviet

45. Before Skobel´tsyn was finally replaced in the UNSAC, he was discredited by members of the science department of the CPSU's Central Committee: 9 July 1957, V. Kirillin, A. Orlov and I. Sebrin, "O rabote akademika Skobel′tsyna D.V. v kachestve predstavitelia SSSR v Konsul′tativnom komitete po ispol′zovaniiu atomnoi energii v mirnykh tseliakh pri General′nom sekretare OON [On the work of academician D.V. Skobel′tsyn as delegate of the USSR in the Advisory Committee on the peaceful uses of atomic energy with the Secretary-General of the UN]," Rossiiskii gosudarstvennyi arkhiv noveishei istorii (RGANI) f. 5, op. 35, d. 53, l. 83–85.

46. 28 October 1959, "United Nations Scientific Advisory Committee, Summary Record of the Forty-First Meeting held at Headquarters, New York," United Nations Archives (UNA) S-262-12-15, 9.

47. 1 and 2 October 1962, "United Nations Scientific Advisory Committee, Summary Records of the 50th, 51st and 52nd meetings held at the Palais des Nations, Geneva," UNA S-262-12-15, 27–28.

48. Even though the world's first nuclear power plant was connected to a Soviet grid in 1954, nuclear energy only became relevant for the Soviet energy industry in the late 1960s and early 1970s.

space program – that would rather prove Soviet prowess in avant-garde technology than in building up a large-scale nuclear energy industry.

There was another important reason behind Emel′ianov's eagerness to give the converter technology prominence in Geneva. Romashka was designed as a prototype for future space nuclear power devices, but nuclear reactor-converters seemed to be of potential terrestrial use too. When Emel′ianov first called for the inclusion of direct conversion in the Geneva program, he spoke of "achievements made at the industrial level." When Romashka was presented to the world as the first nuclear reactor-converter, it heralded promise not only for nuclear space flight but also for the use of nuclear energy in remote areas on Earth, or, to put it more precisely, in countries without nationwide grids. In this respect, Romashka could be displayed not only as a potential space device but also as a technology suited to the promise of nuclear development aid – a key element of Soviet nuclear internationalism in the 1960s.

In the paper given by Ponomarev-Stepnoi in Geneva, Romashka was first and foremost an experimental reactor – a *nuclear thing*. But the message was clear: not only might this technology prepare the ground for "pocket power plants," which could potentially become an interesting nuclear export product, but first and foremost it would enter into competition with the American SNAP program as a promise of future successes in the Soviet space program. As *New Scientist* put it in the immediate aftermath of the 1964 Geneva Conference:

> The Americans at least have no cause to love "Daisy," whose sultry charms caused such a stir at the "Atoms for Peace" conference in Geneva last week. For this "direct conversion" reactor – Romashka in her native Russian tongue – proved to be a significant advance on US achievements in a field that the Americans believed they had to themselves. [...] These pocket-sized power plants are going to prove increasingly valuable for all kinds of remotely-located equipment – in space, at sea, up mountains, in deserts, and so on.[49]

To examine Romashka's importance for the space race, we must ask in what way this *nuclear thing* actually was a *space device*. It clearly was not, as far as its field of operation is concerned. It clearly was, with regards to the reasons that led to its construction in the first place. Whether power units of the Romashka type would actually be used in the Soviet space program was subject to speculation and not discussed on the international stage in 1964. The simultaneity of secrecy in the Soviet space program and the implicit hints dropped with the presentation of Romashka made the project so attractive. Without direct reference to concrete space flight missions, the reactor-converter reinforced the impression that the secret Soviet space program "could be capable of anything."[50] But in Geneva, Romashka was more than just a prototype of another potential space first. It contained the promise of de-centralized small-scale nuclear power production

49. "Russians Unwrap their Pocket Powerplant," *New Scientist* (10 September 1964): 619.

50. Sidiqqi, "Cosmic Contradictions," 48.

and accordingly appealed to countries of the global south, which had to adapt their nuclear ambitions to infrastructural realities. Thermoelectric conversion of fission energy appeared to be one possible solution to energy problems in remote areas without access to national grids.

Irrespective of the fact that the organizers of the 1964 PUAE conference shifted the emphasis from visionary ideas to practical problems of extensive nuclear energy development, Geneva still achieved maximum publicity and thus provided a very welcome stage on which to present Romashka to the world – together with high-flying promises about the power of socialist development.[51] After the auspicious public debut of American nuclear power in space, Romashka was a considerable Soviet success. The comparable American project, SNAP-10a, was also presented in Geneva, but unlike Romashka, SNAP-10a was not yet ready for operational testing in the fall of 1964. As the Soviet Union seemed to take the lead in the race for the promising new reactor-conversion technology, Romashka generated – at least according to a retrospective Soviet account – greater public interest than its American rival.[52] Actually, the *New York Herald Tribune* reported from Geneva that "[...] the Soviet device is ahead of the American in that it has already proved itself as a full system." But the reporter qualified this by adding that "unless they have a parallel program going, they could not, American experts thought, get Romashka in shape to fly before SNAP 10A."[53] A day later, the British *Guardian* reported in turn that the "[...] United States press conference on power in space should have produced some fireworks [...]" but failed to do so.[54] The correspondent even identified "a big technological advance" by comparing Romashka's core temperature with the heat that would be produced by SNAP 10a.[55] The IAEA Bulletin's summarizing article confirmed, finally, that Romashka was the first device to directly convert fission heat into electricity and emphasized its role as one of the masterpieces of the third PUAE conference:

> The direct thermo-electric conversion of the fission heat of a nuclear reactor has been demonstrated. The efforts in the Soviet Union which culminated in "Romashka" are of great interest. [...] The United States hopes to demonstrate in the spring of 1965, with a developmental orbital flight of SNAP 10A, a 500 watt reactor unit also employing thermo-electric power conversion. [...] These reactor units in larger sizes will permit future communication satellites to broadcast simultaneously several channels of television directly to individual homes. It seems clear that these reactor concepts, SNAP and Romashka, while receiving

51. Andranik M. Petros´iants, "Tret′ia mezhdunarodnaia zhenevskaia konferentsiia atomnikov [The third international Geneva Conference of atomic scientists]," *Atomnaia Energiia*, 17, 5 (1964): 329–334.

52. G.N. Alekseev: *Stanovlenie i razvitie iadernoi energetiki* [The making and evolution of nuclear power] (M.: Nauka, 1990), 121.

53. Stuart H. Loory "Russia Reveals Research On Using A-Energy in Space," *New York Herald Tribune* (2 September 1964): 3.

54. Anthony Tucker, "Space Power Problems," *The Guardian* (3 September 1964): 2.

55. Ibid.

their impetus from the needs for space power, will find equally important roles as compact, reliable terrestrial power sources.[56]

Romashka never left the Earth. As an object of the Soviet Union's peace rhetoric and a showpiece of high technology prowess, it nevertheless not only left its imprint on domestic discourses, but gained attention all over the globe as it immediately entered the pantheon of Soviet nuclear achievements. A model of the new reactor-converter was shown at numerous exhibitions all over the world, and the peaceful device served as a shining example of Soviet efforts in nuclear science and technology.[57] Romashka was supposed to draw attention to the non-military efforts of Soviet nuclear science and technology. It showcased the Soviet claim to divert resources away from the military program and it symbolized the capability of a Soviet path of accelerated modernization. In 1964, the promotion of peaceful instead of belligerent uses of atomic energy was more credible than ever before, since the Limited Test Ban Treaty had been signed in Moscow in 1963.[58] Irrespective of the major impression Romashka had made at conferences, in the press or during scientific-technological exhibits, the United States won the next stage in the nuclear powered space race. On 4 April 1965, SNAP 10a was shot into orbit, where it was supposed to operate for one year. Due to an electronics malfunction, the reactor shut down after only 43 days of operation and brought the world's first fission-powered space mission to an early end. At this time nuclear space power was still treated as a field of competition in which the superpowers could prove their techno-scientific prowess to a global public. Additionally, it was clear that, irrespective of all assurances about the purely peaceful intentions behind space nuclear power programs, nuclear reactors in outer space would also be of potential strategic relevance.

Strategic spaces and legal limits – Space nuclear power in context

Spaceflight entered the nuclear programs of both the Soviet Union and the United States early on. In the United States, "Sputnik sparked support for a full-fledged

56. "The Third Conference – A Summing Up," *IAEA Bulletin*, 6, 4 (1964): 7–17, here: 14–15.

57. Between 1955 and 1966, a total of 69 exhibitions on the peaceful Soviet atom were shown outside the Soviet Union. The first model of Romashka was shown at the exhibition at the Third Geneva Conference in 1964. Thereafter, the model was part of virtually every Soviet exhibition on nuclear energy. On the extensive use of exhibitions to promote nuclear energetics as well as political ideology see: Sonja Schmid, "Celebrating Tomorrow Today. The Peaceful Atom on Display in the Soviet Union," in *Social Studies of Science*, 36, 3 (2006): 331–365, here: 338; a short overview on Soviet exhibiting activity in the field is given in: V. Mikhailin, "Vystavke 'Atom dlia mira' 10 let [Ten years of the 'Atoms for Peace' exposition]," in *Atomnaia Energiia*, 21, 3 (1966): 229–230.

58. On the LTBT see: Vojtech Mastny, "The 1963 Nuclear Test Ban Treaty: A Missed Opportunity for Détente?" in *Journal of Cold War Studies*, 10, 1 (2008), 3–25; Allan Pietrobon, "The Role of Norman Cousins and Track II Diplomacy in the Breakthrough to the 1963 Limited Test Ban Treaty", in *Journal of Cold War Studies*, 18, 1 (2016), 60–79.

effort" in this direction and in the Soviet Union, the first plans to design a reactor for space propulsion were also formulated as early as 1958.[59] As the historians Simone Turchetti and Peder Roberts recently stressed, the enormous growth of scientific knowledge at the dawn of the space age was strongly connected with a massive extension of intelligence monitoring and strategic data collection – data not only about the planet, but also about outer space. After the launch of Sputnik 1 in October 1957, the cosmos became an infinite field of interrogation and, at the same time, a strategic space with possible relevance for agencies concerned with national security.[60] Long before Reagan's infamous "Star Wars," the militarization of outer space was on the agenda of national and international policy making.

The United Nations' General Assembly adopted a first resolution on the "Question of the Peaceful Use of Outer Space" in late 1958.[61] An ad-hoc committee consisting of 18 member states, including the Soviet Union, was set up, starting its work in May 1959 and transformed to a permanent committee (COPUOS) later that same year. Eisenhower addressed some of the legal problems arising with the beginning of the space age in a speech in 1960, not long after he had publicly announced the first nuclear battery designed for potential use in outer space. Before the United Nations General Assembly he stated that

> [...] technology is [...] in revolution. It has brought forth terrifying weapons of destruction, which for the future of civilization, must be brought under control through a workable system of disarmament. And it has also opened up a new world of outer space – a celestial world filled with both bewildering problems and dazzling promise.[62]

Eisenhower linked the international implications of spaceflight with the unpleasant history of nuclear diplomacy. He claimed that the Soviet Union had missed the opportunity to place nuclear energy under international control in 1946. Fourteen years later, Eisenhower argued: "We must not lose the chance we still have to control the future of outer space."[63] In the Soviet Union, the cosmos was also

59. Hewlett and Holl, *Atoms for Peace and War*, 519; V.A. Kniazev, "Gipoteza Millionshchikova, ili 'Vremia tvorit biografii' [The millionshchikov hypothesis, or 'Time makes biographies'']," in N.E. Kukharkin, ed., *Mikhail Dmitrievich Millionshchikov. K 100-letiiu so dnia rozhdeniia* [In celebration of the Birth Centenary of Mikhail Dmitrievich Millionshchikov.], 122–134, here: 129.

60. Simone Turchetti and Peder Roberts, "Knowing the Enemy, Knowing the Earth", in Simone Turchetti and Peder Roberts, eds., *The Surveillance Imperative: Geosciences during the Cold War and Beyond* (Basingstoke: Palgrave Macmillan, 2014), 1–19.

61. 13 December 1958, UN General Assembly Resolution 1348 (XIII), "Question of the Peaceful Use of Outer Space", online: <https://undocs.org/en/A/RES/1348(XIII)> (09 July 2019).

62. 22 September 1960, Dwight D. Eisenhower, "Address before the 15th General Assembly of the United Nations", New York City, online: <http://www.presidency.ucsb.edu/ws/?pid=11954> (07.09.2018).

63. Ibid.

seen as a strategic space. Still, no concrete steps towards a militarization of space devices or celestial bodies had been taken. In 1962, the year after Iurii Gagarin's first spaceflight, a somewhat disappointed Soviet deputy of the Soviet air force commander noted in his diary that the decision-makers in the General Staff "[...] have been missing opportunities for us to become the first in creating a space force [...] which could facilitate the domination of Communism on Earth."[64] Even though the militarization of space, as imagined by the author of these lines, lacked support, the military implications of spaceflight were obvious throughout the space age. The possibilities for reconnaissance missions in the cosmos alone seemed to be almost limitless. On the one hand, outer space – or the cosmos – had become another stage for Cold War competition. By the mid-1960s its potential militarization actually seemed to threaten the existing order between the superpowers. On the other hand, the Limited Test Ban Treaty (LTBT) of 1963 had demonstrated that international agreements on pressing problems arising from technological progress were possible, provided that the Soviet Union and the United States showed a certain willingness to compromise. Only a week after the LTBT had entered into force, the UN General Assembly adopted a resolution on the "Question of general and complete disarmament", calling all member states "to refrain from placing in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, installing such weapons on celestial bodies, or stationing such weapons in outer space in any other manner."[65]

While Romashka was celebrated as a huge success of Soviet science, the diplomatic problems of ever-growing space missions remained unresolved. The first international legal framework for the exploration of space entered into force only on 10 October 1967.[66] Due to its prototypical nature, Romashka was not affected by this outer space treaty. But its design had inspired other projects in the Soviet Union. During the years of negotiation preceding the outer space treaty of 1967, new space devices were developed with great vigor on both sides of the Iron Curtain. In the Soviet Union, other reactor-converter designs were developed, involving several research institutes, which often created specialized branches working exclusively on space nuclear power projects.[67] In 1963, a group of scientists and engineers in

64. N.P. Kamanin, *Skrytii kosmos* [Hidden space], vyp. 1 (M.: Infortekst-IF, 1997), 174–175, cit. in Zubok, *Failed Empire*, 145.

65. 17 October 1963, UN General Assembly Resolution 1884 (XVIII), "Question of General and Complete Disarmament", online: <https://undocs.org/en/A/RES/1884(XVIII)> (09 July 2019); Eisenhower's speech in 1960 had already led to Resolution 1721 (XVI), adopted on 20 December 1960 and recalled in the quoted Resolution.

66. Its basic features can be summarized as follows: the signatories agreed not to place any weapons of mass destruction, especially nuclear weapons, in outer space. Nobody had a right to claim possession of any celestial body, while, at the same time, every state was responsible and liable for everything they launched into space from their territory: "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and other Celestial Bodies," online: <https://treaties.un.org/doc/Publication/UNTS/Volume%20610/volume-610-I-8843-English.pdf> (09 July 2019).

67. Orlova, "Fiziki-iadershchiki," 113–114.

the KIAE, among them the physicist and member of Millionshchikov's Romashka team, Nikolai N. Ponomarev-Stepnoi, began working on another reactor-converter project under the name Enisei in close cooperation with other institutes.[68] At the same time, work began at the Institute of Physics and Power Engineering (Fiziko-energeticheskii institut; FEI) in Obninsk on both the thermoelectric reactor-converter Buk (BES-5) and its thermionic alternative Topaz.[69] Even though all of these projects differed from each other of course in several respects, it is note-worthy that the Soviet nuclear space power program continued to strongly rely on fission reactors. In the United States, the failure of the SNAP-10a project had largely marked the end of the American space reactor program.[70] After 1965, the United States still used nuclear power in space, but exclusively applied radioisotope generators to its atomic-powered spacecraft. The Soviet Union, on the other hand, having spent the first half of the 1960s ground-testing and promoting their reactor-converters, and having launched two RTG-powered satellites in September 1965, further extended its space reactor program. While neither Romashka nor Enisei ever flew to outer space, Buk reactors powered many reconnaissance satellites throughout the 1970s and 1980s.[71]

In 1964, Mikhail Millionshchikov had been appointed head of the Soviet Pugwash group. Not only Romashka's career, but also the careers of the scientists behind its realization were of course always dependent on the CPSU's nuclear foreign policy. Even though travelling to different kinds of conferences created opportunities for informal exchange with "Western" peers, such appointments also meant that top-scientists became integrated in the well-orchestrated system of Soviet cultural diplomacy, often acting more or less as official representatives of the Soviet state.[72] Similar to Romashka in 1964, the thermionic reactor-converter Topaz was presented to the world during the fourth PUAE conference in Geneva in 1971 and later was roughly described in the popular journal *Atomnaia Energiia*, which was also published in English.[73] Topaz was only used on some experimental missions in the late 1980s. It was introduced to the West in 1989, at a symposium

68. Kukharkin, Ponomarev-Stepnoi and Usov, *Kosmicheskaia iadernaia energetika*, 70; a comprehensive list of people involved in the Enisei-project is provided in ibid. 116–136.

69. Ibid. 70; Orlova, "Fiziki-iadershchiki," 114.

70. Gary Bennet, "A Look at the Soviet Space Nuclear Power Program," in William D. Jackson, ed., *Proceedings of the 24th Intersociety Energy Conversion Engineering Conference*, vol. 2 (New York: Institute of Electrical and Electronics Engineers, 1989): 1187–1194.

71. The first Buk type reactor was launched on 3 October 1970 aboard the satellite Kosmos 367. It powered the first US-A satellite. US-A satellites were used for ocean surveillance and became known in the West under the English acronym for Radar Ocean Reconnaissance Satellite, RORSAT.

72. Questions on the role of Soviet scientists as cultural diplomats have recently been discussed in Nagornaia, ed., *Sovetskaia kul'turnaia diplomatiia.*

73. V.A. Kuznetsov et al., "Razrabotka i sozdanie termoemissionnoi iaderno-energeticheskoi ustanovki 'Topaz' [The development and creation of the thermionic nuclear power Unit 'Topaz']", *Atomnaia Energiia*, 36, 6 (1974): 450–457.

in Albuquerque.[74] However, Buk, the only reactor which actually powered space devices on a regular basis, was kept away from the limelight due to the military purpose of the satellites it supplied with energy. The reactor-converter program as a whole can be seen as an enterprise with obvious dual-use potential. While Buk flew into space, powering Soviet ocean surveillance, Romashka did not fly anywhere but still reached out to the whole world as an idea, as an attraction at exhibitions or as a symbol of socialist development.[75] Millionshchikov remained an important mediator in science diplomacy, highly recognized in East and West, not least because of his successful and highly visible work as one of the key figures in the Romashka project and irrespective of the fact that he often acted as a mediator of state interests.[76]

The major Soviet reactor-converter projects headed off in different directions. Regarding international implications, Enisei played an extraordinary role during Perestroika and beyond. In 1989, initial negotiations took place concerning potential Soviet–American lab-to-lab cooperation, aiming to further develop parts of the Enisei system, known in the United States as Topaz II.[77] In 1991, Ponomarev-Stepnoi used his participation at the Albuquerque Symposium to propose the sale of Topaz II technology to the United States. This project survived the disintegration of the Soviet Union and, according to a retrospective program overview "[...] would become the preeminent example of technology cooperation between two former adversaries."[78] In 1992, the first two Topaz II systems were transported from St. Petersburg to Albuquerque, where Soviet and American scientists and engineers carried out a series of collaborative experiments. Even though such plans existed, Topaz II was never used in any flight program before funding for the project was cut and the equipment returned to Russia in 1996.[79] Since the end of the Topaz II International Project, there have been attempts to revive yet another idea concerning the possible international afterlife of Soviet reactor-converter technology. Taking up the internationalist appeal of Romashka at the 1964 Geneva conference, the Russian physicist Anatolii V. Zrodnikov, who had actively participated in the converter projects at the FEI in Obninsk, advertised

74. David Buden, "Summary of Space Nuclear Reactor Power Systems (1983–1992)," manuscript prepared for the Tenth Anniversary Book for Symposium on Space Nuclear Power and Propulsion in Albuquerque, New Mexico, 1993, online: <https://www.osti.gov/servlets/purl/10151265> (09 July 2019); beginning in 1984, these symposia were held annually and became a central meeting point for specialists in nuclear space power.

75. On the different perception of Romashka and Buk see Orlova, "Fiziki-iadershchiki," 114.

76. He was involved in the Soviet–American Disarmament Study Group (SADS) and later acted as the head of the Soviet Pugwash group until the end of his life: Evangelista, *Unarmed Forces*, 38–39.

77. Kukharkin, Ponomarev-Stepnoi and Usov, *Kosmicheskaia iadernaia energetika*, 141–154.

78. Frank V. Thome et al., "A Topaz International Program Overview," *AIP Conference Proceedings* 324 (1995): 725–731.

79. Richard Dabrowski, "U.S.-Russian Cooperation in Science and Technology. A Case Study of the TOPAZ Space-Based Nuclear Reactor International Program," *Connections*, 13, 1 (2013): 71–87, here: 71–72.

former nuclear space technology as a possible basis for civilian applications in developing countries during an international seminar in India in 1998.[80]

Conclusions

The history of Soviet nuclear internationalism is a history of ambiguities. Analyzing the development of space nuclear power projects helps us understand some of the ideas and processes shaping nuclear internationalism in the Soviet Union in the 1960s. The international history of space nuclear power co-emerged with the space age – at a time when the first PUAE conferences seemed to bring scientific communities from all nuclear states back together, and when the Cold War heated up in the double crisis of Suez/Hungary and the U-2 affair and finally peaked at Checkpoint Charlie in Berlin and in Cuba. Secrecy, control, regulation and state propaganda were constant companions of any cross-border flow of knowledge and data. It was in this setting of simultaneous conflict and competitive cooperation that the Romashka project was started. The reactor-converter became the first epitome of Soviet space nuclear power, even though it remained on Earth. To some extent, Romashka*'s* popularity owed to the strict regime of secrecy hiding other reactor-converter projects like Buk or Topaz. It was not until the Perestroika years that the Enisei/Topaz II project entered the international arena, in an attempt to preserve the unique Soviet converter technology through cooperation with an institute in the United States. In the meantime, the Soviet nuclear space program suffered a couple of harsh setbacks – accidents which even tore some holes in the veil of secrecy shrouding projects with potential or actual military significance. In April 1973, a nuclear reactor of the Buk type fell into the Pacific, and in September 1977 another reactor of this type crashed on Canadian territory, not only causing major public concern but also requiring a costly recovery mission.[81]

The logic of Soviet nuclear internationalism restricted movement of knowledge to a certain kind of technology. While projects of direct military relevance were kept secret, the CPSU's decision-makers were convinced that presenting so-called peaceful nuclear applications to a global public was desirable. Given that international exchange – although strictly limited – became possible in the field of non-military nuclear energy in the mid-1950s, it was Romashka's nuclearity which brought it to international attention despite the almost complete secrecy prevailing in the space program. Both its significance for spaceflight and its dual-use potential were mostly implicit. Romashka's explicit nature was nuclear, peaceful and even linked to the promise of nuclear development aid. Still, it was the very nexus

80. A.V. Zrodnikov: "Nuclear Power Technologies for Application in Developing Countries," in *International Seminar on Nuclear Power in Developing Countries: Its Potential Role and Strategies for its Deployment, Mumbai (India), 12–16 Oct 1998* (Vienna: IAEA, 2000): 71–83.

81. Lisa Ruth Rand, "Falling Cosmos. Nuclear Reentry and the Environmental History of Earth Orbit," *Environmetal History*, 24, 1 (2019): 78–103, here: 84–88.

between space and fission that made it so attractive for international promotion. Even if the anecdote in Rosatom's encyclopedia is probably a little exaggerated, the Soviet space program actually seemed to be capable of almost everything in the early 1960s and some observers actually thought it possible that the Soviet Union would be the first state to shoot a working nuclear reactor into orbit. For Romashka's international career, the technology itself was decisive. Still, the nuclear reactor-converter could only become a showpiece of Soviet nuclear internationalism because the people who created and promoted it acted skillfully as cultural brokers between the Soviet Union and "the West" as well as between respected ideas about epistemic communities and science-policy debates on secrecy and moderate candor.

Accordingly, the questions why and how knowledge about Romashka moved across borders are tied to particular people in science and science administration. Scientists like Millionshchikov or Ponomarev-Stepnoi had the privilege to work on cutting-edge technology and at the same time were obliged to represent the Soviet Union – especially its official discourse about nuclear energy and socialist progress – abroad. They clearly were part of what Ol´ga Nagornaia called a cohort of public persons to whom the CPSU's leadership entrusted the task of promoting scientific achievements in order to support the Soviet Union's claim to be one of the world's leading powers.[82] It would, however, be wrong to reduce their scope of action to the mere amplification of state propaganda, as their inclusion in international networks – from Geneva to Pugwash – often went hand in hand with the appointment to influential positions in the Soviet science administration or to advisory bodies. Romashka's international career was shaped by a set of ideas, processes and phenomena subsumed under the integrative concept of nuclear internationalism. In turn, the international success of the reactor-converter was also a result of the efforts of its creators. Through them, the windows to "the West" that were opened to promote Romashka also helped shape and change the fabric of nuclear internationalism itself.

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82. Nagornaia, "Kul´turnaia diplomatiia," 100.