Prophet of our times

John M. Charap

Sakharov Remembered: A Tribute by Friends and Colleagues. Edited by Sidney D. Drell and Sergei P. Kapitza. *Hilger/American Institute of Physics*: 1991. Pp. 303. £19.95, \$29.95 (hbk); £13.50, \$19.95 (pbk).

Andrei Sakharov: Facets of a Life. Editions Frontières: 1991. Pp. 730. FF295, \$50, £27.

JUST hours before he died in December 1989, Andrei Sakharov had addressed the Congress of People's Deputies, pleading once again the urgent need for reform, political pluralism and constitutional change. Three years earlier, Mikhail Gorbachev had telephoned to tell him "resume your patriotic work", thus ending his seven years of exile in Gorky. Sakharov had exhausted himself arguing for radical *perestroika*. His 'draft constitution' was never adopted, although it included reforms that are now being introduced as a result of the convulsions that have transformed the Soviet Union since his death.

The essays in *Sakharov Remembered* (many of them reprinted from special issues of the American Institute of Physics journal *Physics Today* and the Soviet Academy of Sciences magazine, *Priroda*) complement Sakharov's own *Memoirs* (Hutchinson, 1990) and *Moscow and Beyond* (Knopf, 1991). Susan Eisenhower and Roald Sagdeev believe that the Sakharov phenomenon (a phrase first used by his teacher, Igor Tamm) is virtually certain to attract the interests of generations of scholars, historians and biographers. These essays show why.

Sakharov's name was unknown in the West before his election to the Soviet Academy of Sciences at the unprecedentedly young age of 32. Even in the Soviet Union his work was known only to those with access to the secrets of Sarovskaya Pustyn (which Sakharov himself, with scrupulous respect for state security, always called simply "the installation"). He had "worked with enthusiasm" in this "Soviet Los Alamos" since 1948, earning the soubriquet 'father of the Soviet H-bomb'; for this he was elected to the Soviet Academy of Sciences, and honours were heaped on him by the State. Yu A. Romanov and V. I. Ritus, his colleagues at the academy, give what I believe to be the first declassified description of Sakharov's H-bomb design — a spherical, layered structure of ${}^6\text{LiD}$ and ${}^{235}\text{U}$ (or ${}^{239}\text{Pu}$) surrounded with unenriched natu-

ral uranium (${}^6\text{Li}$ generates tritium under bombardment from fast neutrons produced in the ${}^{235}\text{U}$ fission reaction, and this in turn fuses with the deuterium). This 'layer cake' leads to what the authors call "sakharization", enhanced yield through compression of the light elements; the natural uranium cladding contributes to this because of its high density, but also further enhances the energy released by fast-neutron-induced fission. Hans Bethe confirms that it was this "third idea" of Sakharov which in 1955 brought the Soviet Union level with the United States in H-bomb technology.

The announcement of the first Soviet H-bomb test coincided with Sakharov's election to the Soviet Academy of Sciences, and an acute observer might have

the Universe, in which he suggested that the proton might be unstable: non-conservation of baryon number, together with C and CP violation could, during an epoch of thermal disequilibrium, then generate an excess of baryons even from symmetric initial conditions. His work on particle physics (for example, on meson masses) and cosmology continued up to, and indeed into, the time of his exile.

And of course, what makes the Sakharov phenomenon of such compelling interest is not his scientific achievement, but the events that led to his exile; his extraordinary courage and endurance, which earned him admiration and respect far transcending what his scientific achievements alone would have brought; and the moral leadership that

Sakharov with his wife, Klavidia Alekseyevna Vikhireva, and their children in the 1960s.

seen the connection. But as I. N. Golovin and V. D. Shafranov recall, it was a seminar on controlled thermonuclear fusion given at Harwell by Igor Kurchatov in 1956 that brought Sakharov's name to the attention of a wider international community. In his talk, Kurchatov described the tokamak design for magnetic confinement, which was conceived and elaborated by Sakharov and Tamm. As the magnetic thermonuclear reactor, this design has had recent success in the approach to controlled fusion at the Joint European Torus (JET) in the United Kingdom.

Sakharov worked on a whole range of problems related to fusion: muon catalysis (on which he wrote as early as 1948); generation of superstrong (hundreds of tesla) pulsed magnetic fields by "magnetic cumulation", converting the chemical energy of an explosive into magnetic energy by compressing a solenoid; the proposed initiation of fusion in deuterium using a pulsed laser. But at the same time he worked in fields far removed from applied physics. In 1965, he speculated that quantum fluctuations might be the seeding inhomogeneities responsible for the formation of galaxies, and two years later in his paper on induced gravity he showed how Einstein's theory might be an effect of vacuum fluctuations in quantum fields on a background metric. Perhaps his most remarkable work was on the baryon asymmetry of

he gave through his persistent advocacy of human rights, of an end to nuclear confrontation and of the cause of freedom. The essays in *Sakharov Remembered* trace the development of his increasingly bold and open commitment to these causes, which would inevitably bring him into direct confrontation with the state and its masters. Maybe his childhood and upbringing prepared the ground. But it was in the installation, where growing anguish over the deaths caused by fallout from atmospheric nuclear tests brought him into direct conflict with Nikita Khrushchev, that he first set out on the path that would lead to his Nobel Peace Prize citation as "the spokesman for the conscience of mankind".

Sakharov's efforts to halt the tests met at first with crude rejection: but he persisted, with arguments backed by calculations of the biological and genetic damage that continued tests would cause. He took these arguments to the very top by writing to Khrushchev, and was at last instrumental in securing the Limited Test Ban Treaty of 1963. His conviction that the threat of nuclear holocaust was of overriding importance never left him. "The elimination of that threat takes unquestionable priority over all other problems in international relations", as Sidney Drell and Lev Okun quote him in their excellent essay on "Physics, the bomb and human rights".

Reproduced from Sakharov Remembered.

That threat may have receded, but we still live under its shadow.

Sakharov wrote again to Khrushchev in 1964, this time on an issue for which he had been slanderously attacked in *Izvestiya*, and criticized at the plenum of the Central Committee of the Communist Party of the Soviet Union (CCPSU). The issue? His crucial speech that blocked the election of N. I. Nuzhdin to the Soviet Academy of Sciences. For Nuzhdin was a "faithful companion" of Trofim Lysenko, who regarded Sakharov's intervention as "a criminal matter". And it is reported that Khrushchev was so furious that he threatened to abolish the academy. (This did not occur; Khrushchev was dismissed from office in October 1964.) The pernicious sway of lysenkoism over Soviet genetics was broken by Sakharov's speech. B. M. Bolotovskii extensively quotes eyewitness accounts given to him by Tamm and Sergei Syrovatskii, as well as Sakharov's own reply to *Izvestiya* and his letter to Khrushchev. (Bolotovskii was the Communist Party organizer in the theoretical department of the academy's Lebedev Institute (FIAN), assigned by the party committee to "oppose" Sakharov during his years there.)

Khrushchev's denunciation of Stalin at the Twentieth Congress of the CPSU, and Roy Medvedev's polemic *Let History Judge*, impressed Sakharov deeply. His strong humanitarian convictions now led him to increasingly public protest and action. In 1968, his *Reflections on Progress, Peaceful Coexistence and Intellectual Freedom* was distributed through samizdat, and as tamizdat some 20 million copies were printed abroad. This cost him his job at the installation, and although he was allowed to join FIAN, he was now in official disgrace.

In the course of his human-rights campaigns, he met and married Elena Bonner, and when he was refused permission to travel to Oslo it was she who received the 1975 Nobel Peace Prize on his behalf. The abuse and vilification in the Soviet press rose to a peak. For protesting against the invasion of Afghanistan, Leonid Brezhnev exiled Sakharov to Gorky by a decree that had no status under Soviet law. During his seven years there, he suffered the appalling indignities of force-feeding when he went on hunger strike, and the spite of the KGB.

Both these books recall the disgust and anger of the scientific community, the moral support of his colleagues at FIAN and the unquenchable strength of his personal concerns, which always moved swiftly from general principles to concrete particulars. But it is to *Facets of a Life* that one should turn for passion and immediacy. It is easy to find fault with this "physicists' tribute" assembled by the theoretical department at FIAN.

It is untidy and uneven, with no evidence of editorial organization apart from alphabetical ordering by author; the English is distinctly Slavic; the subject-matter is often repetitive; there is no index, making cross-reference between the 60 contributions difficult. But for all that, I cannot recommend it too highly. Here is Sakharov as seen by those who grew up with him and worked with him; those whose lives were intertwined with his, who took risks on his behalf or who feel guilty that they did not risk enough. Not an icon of a saint, but sketches towards a portrait of the man.

The clamorous, argumentative essays jostle for attention. Many of them read like evidence at a tribunal, and most are concerned with setting the record straight. For example, there are agonizing attempts to clarify how Sakharov passed certain papers from Gorky to Moscow, one of which was a letter to Anatoly Aleksandrov, president of the academy. This letter, written *in extremis* to appeal for help before he began a hunger strike to secure permission for Elena Bonner to travel abroad (to visit her family and for medical treatment), is a heart-rending document, reproduced in the essay by Vitaly Ginzburg. But it was delivered a year late because of the scruples and hesitation of the "couriers". Not only Ginzburg, but also Boris Altshuler, Dmitry Chernavsky and

Evgeny Feinberg give their versions of what led Sakharov to write: "I have learned some details of what was going on in Moscow during my hunger strike and understood (but not reconciled myself to) the reason of [sic] disappearance of one of my documents."

Boris Altshuler's article, aptly headed with a quotation from Andrei Sinyavsky's — "I shall speak straight because life is short" — is packed with examples of Sakharov's knowhow; the achievement of strategic objectives by concentrating on concrete particulars. Altshuler had himself been fired as a physicist for his human-rights activities, and worked for many years as a caretaker. Feinberg addresses "the future historian" who will "understand Andrei Dmitrievich better than we, his contemporaries, obsessed with the intertwined and sometimes contradictory emotions and opinions." He emphasizes that Sakharov's political views evolved; it was this that perhaps gave them greater strength and maturity. Many of the authors speak of Sakharov's total integrity, the simplicity of his lifestyle, his apartness; he was regarded by some as a prophet. He surely touched their lives, and the shaping and direction of *perestroika*. And so our lives too. □

John M. Charap is in the Department of Physics, Queen Mary and Westfield College, Mile End Road, London E1 4NS, UK.

Alien life

Frank J. Tipler

The Cosmic Water Hole. By Emmanuel Davoust. MIT Press: 1991. Pp. 206. \$19.95, £17.95.

NEXT year, on Columbus Day, US researchers will begin a ten-year, \$100-million programme to search for extraterrestrial intelligence. Davoust, a French astronomer, provides a very readable popular description of this and other efforts to detect radio transmissions made by extraterrestrial intelligence. But his book marks an important change from the vast numbers previously published in this genre: he admits that the search will probably fail because such intelligence probably does not exist. It is refreshing to see an astronomer join the biologists, who, according to the distinguished biologist Ernst Mayr, are "... almost uniformly skeptical of the probability of extraterrestrial intelligence".

Davoust accurately expresses the force of the Fermi paradox: if extraterrestrial intelligences exist, why are they not already here? Even our primitive rockets can reach the stars in 10^5 years. Computer experts (such as Hans Moravec in

Mind Children, Harvard University Press, 1988) tell us that within 50 years we should be able to make an intelligent computer capable of self-reproduction. The combination of our primitive rockets with a payload of self-reproducing robots would be sufficient to explore and colonize the Galaxy. With such a probe, this would take only a few hundred million years to accomplish. We know that if our own evolution is typical, then most civilizations in our Galaxy must have arisen billions of years ago. Thus most experts now admit that civilizations so advanced would be here if they wished to come.

Davoust devotes an entire chapter to possible sociological mechanisms that might prevent interstellar travel. But I think he neglects the crucial point: virtually any motivation we can imagine that would lead extraterrestrials to engage in interstellar radio communication with us would also motivate them to engage in interstellar travel. The above-mentioned radio search is for civilizations wanting to contact us, for our equipment is not powerful enough to eavesdrop. Although we do not know the motivations of all advanced civilizations, we thus do know the motivation of the civilizations we search for. But robot probes would achieve the aims of these civilizations much better than radio sig-