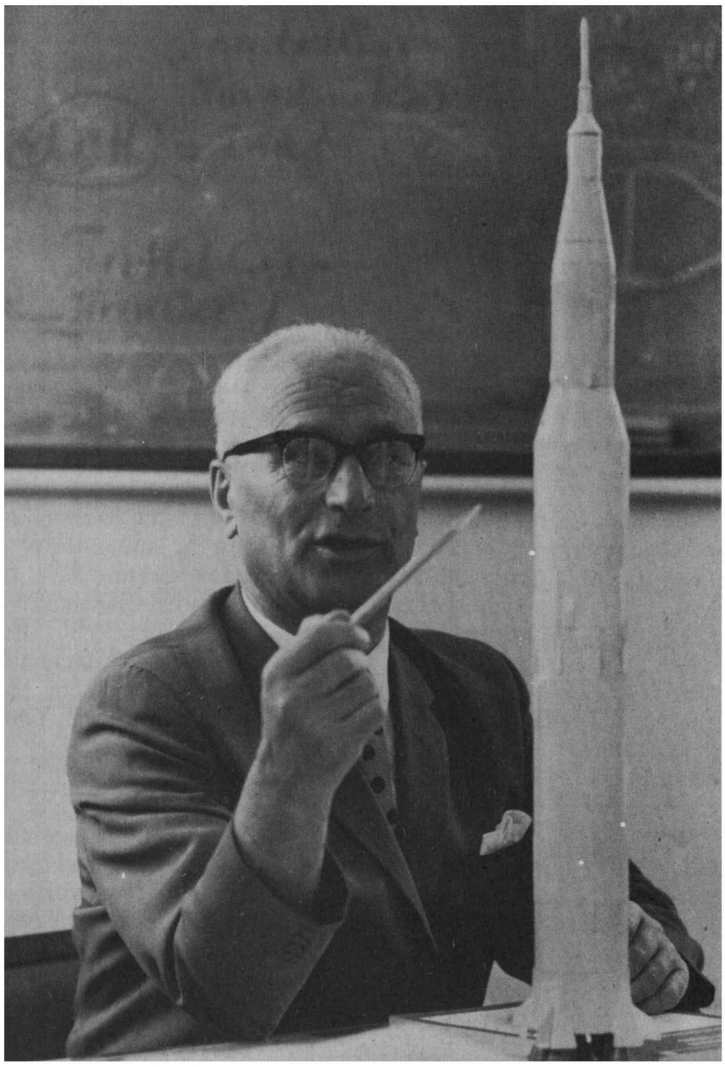
Tokaty, space pioneer



The son of a peasant farmer whose life opportunities were totally transformed by the revolution, became first a tractor driver and then an aeronautical engineer. He had become the USSR's chief rocket scientist when he moved to Britain in 1948. He talks to Dr Sarah White of his career and enthusiasm for space exploration

Professor Grigori Tokaty is in the unique position of having spanned two worlds in one lifetime. He has worked professionally on both the American and Soviet space programmes, he has taught in both Soviet and western higher educational institutions, and he has lived under both the socialist and capitalist systems. Although he is careful to avoid discussion of politics, Professor Tokaty firmly believes that the October Revolution was probably the greatest single event in the whole history of mankind. It certainly profoundly affected the individual lives of the millions of people living within the old Russian Empire, and Grigori Tokaty was one of them.

He was eight years old when the revolution took place, the son of north Ossetian peasant farmers living in the North Caucasus. He had three older brothers who were active in the revolution. It is difficult for us living in Britain in 1971 to imagine the sort of boyhood Grigori Tokaty had. He gave me a striking simile when he mentioned how a recent Times picture of a little Vietnamese boy wearing ragged clothes and outsize American boots and rummaging around for food, reminded him of himself at that age. He is personally quite unaware of what normal schooling is, having never spent a single hour behind an ordinary school desk. But his life certainly had its compensations, and many might envy the experience of living at the centre of such a unique and significant period of history. As Professor Tokaty described it "the revolution was such an epoch that each year counted for 10 normal years".

He cannot remember how he learnt to read and write but during the 1920s the Soviet government launched a tremendous campaign to wipe out illiteracy in the country, and by 1929, at the age of 19, he was being sent by the local trade union committee to the Workers Faculty of the Leningrad Mining Academy. Here was another example of the revolution at work. One of its major ideals was to give ordinary people the chance of as much education as possible. The campaign against illiteracy was one aspect of this ideal. The Workers' Faculties, better known as Rabfaks, were another. These were specially organised for people like Tokaty, who came from ordinary working class or peasant families. They had never had the chance of primary or secondary education before the revolution, and then the civil war and wars of intervention that followed 1917 had disrupted any formal education that the government might have been able to organise in the 1920s. The Rabfaks gave these people a chance to make up for what they had missed and then to go on to higher education. Khruschev is another example of someone who attended a Rabfak.

Tokaty earned his chance of higher education by working well as a tractor driver. He thinks he was probably one of the first such drivers in the North Caucasus when he started working at the beginning of 1925. The tractor he used was an old American

Fordson model—part of a consignment that the government had imported to help raise the level of agriculture.

His early acquaintance with tractors meant that Tokaty's first idea was to study mechanical engineering with an eye eventually to specialising in locomotives. He did specialise in mechanical engineering in the Rabfak of the Bauman Higher Technological College in Moscow (he had moved to Moscow soon after starting his studies when the educational reforms of the first five-year plan transferred the Leningrad Mining Institute there). But when he finished in 1932, the Party stepped in to put him on the path to aeronautics and space research. Tokaty was by now a member of the Communist Party, and he was drafted along with many other students into the Soviet Air Force, as part of the so-called "Party Thousand", ie, it was a mobilisation to meet the needs of the armed forces. The Air Force sent him to its world-famous Zhukovsky Academy, where he spent the next five years doing his degree. After this things moved very swiftly for Tokaty. In 1937 the state commission which heard the defence of his graduation thesis, decided he should remain in the Academy as a research engineer in the aerodynamics laboratory. A year later he was appointed head of the same laboratory—a tremendous honour for someone only 28 years old—and stayed there until 1941.

This appointment was highly significant for the young Tokaty, who seven years before would never have dreamt he could have achieved such a position. He was working in a key aeronautical research institute, where giants of the Soviet aerospace industry such as Ilyushin, Kuznetsov, Yakovlev and his contemporary Mikoyan, had also studied; his immediate superiors and colleagues in the Zhukovsky Academy included many of the founders of Soviet aeronautics—Academician Boris N. Yurev, Academician Boris S. Stetchkin, Vladimir V. Golubyev, Professor Boris M. Zemsky, among others; the new position and these influential people brought him into direct contact with other organisations working along similar lines—the State Flight Testing Institute and the Central Aero- and Hydrodynamic Institute, which shaped Soviet aviation and rocketry, were two. Tokaty had had an amateur interest in rocketry since about 1933 when he met Konstantin Tsiolkovsky and read Eugen Sanger's Raketentechnik. And now he was in almost daily contact with the so-called Bureau of New Technology. This was organised for the express purpose of studying new world trends in science and technology, including rocketry.

Rocketry takes over

A disagreement with the authorities brought his appointment as head of the Aerodynamics Laboratory to an abrupt end in 1941, though Tokaty is pleased to add that his scientific colleagues backed his stand in the matter. But this setback did not deal his career much of a blow, instead it helped him to diversify his interests. He remained at the Zhukovsky Academy as a lecturer, took up professional work at the Moscow Engineering Institute, became involved with the Central Aero- and Hydrodynamic Institute, and continued his study of rockets, among other things.

By the time the end of the war came, Tokaty was one of the few Russians who knew the German work on rockets well. Along with other top experts—including Korolyev, who was to become the father of the Soviet space programme—he was sent by the government to Germany to study German research and development work in jet aviation and rocketry. At this point Professor Tokaty mentioned with a laugh how he had found himself for a few months in the slightly anomalous position of being co-opted on to the Soviet Secretariat of the Allied Control Council in Berlin—a result of his ability to speak several European languages. After working in Germany, where incidentally he found that all the top German rocket experts had already fled to America leaving only a rather motley second-rate crew for the Russians to inherit, Tokaty was appointed chief rocket scientist of the USSR in 1947. He came to Britain in 1948.

To London

Professor Tokaty does not talk about the ideological reasons which led to his abandoning his successful career in the USSR to live in London. But he does not appear to be at all bitter about his experience, and his pride in Soviet achievements in space is clear when he talks on the radio about another Luna or Soyuz flight. It is a refreshing contrast to the sterile black and white stereotyped attitudes that so often emerge out of similar situations.

Since coming to London he has worked for the government, at Imperial College and the College of Aeronautics at Cranfield, in the United States, and then back in England. For the past 15 years, he has been as he says in his own words, "one of the most dedicated rocket and space scientists", closely connected with the Mercury and Apollo programmes. At the same time he has remained acutely interested in the Soviet space programme.

In 1961 Tokaty became head of the department of aeronautics and space technology at the Northampton College of Advanced Technology, now the City University. Today this department is unique in several respects playing an important role in the development of theoretical rocket dynamics. Tokaty himself has been concentrating recently on the mathematical theory of rocketry and space exploration.

Tokaty has clearly thought deeply about the implications of his work, and he was rather critical of New Scientist, among other journals, for tending to ignore the essential problem in his view—namely, the fact that the scientific and technological content of life is becoming too sophisticated, too complex and too bulky for the traditional forms of organisation of society to accommodate it comfortably. He sees space science and technology as just two of the clearest indicators of this situation. They have reached such a stage of development that they are far beyond the

grasp of an average citizen of any country. Automation, which is an essential part of space technology, is beginning to penetrate into all aspects of modern life. And yet the structure of society remains basically the same. He cited the average university as an example of what happens when there is no radical restructuring of institutions to accommodate changed conditions. In the past lecturers lectured because they had no adequate materials to speak of at their disposal. Today, however, no lecturer can ever hope to deliver even a fraction of the knowledge which is already in existence and written down. Yet we continue to lecture in the same way, and are surprised when the students become restless.

Crisis for society

Tokaty sees this rapidly growing discrepancy between the scientific and technological content of life and its traditional forms of organisation as probably the major conflict of our epoch. He compared it with a high pressure vessel which is having more and more pumped into it, and which must eventually blow up. Either we adjust our social structure or we explode. Rolls-Royce and Upper Clyde Shipyards are two local symptoms. What Tokaty would like to see is a serious debate and analysis of this problem in New Scientist and other journals.

His emphasis on the need for analysis is a good reminder of his non Anglo-Saxon background. He clearly finds the British and American pragmatic approach rather out of step with modern needs. He spent his formative years in a society which was geared to one ideal—the building of a new society, socialism and communism. Here the individual was working for the improvement of the whole of society, and for that moment he did not care about his individual needs—whether he was hungry or badly clothed—because he believed in what he was working towards. Tokaty sees the need for every nation to have some underlying philosophy, a national ideal, a sense of common effort.

The same point came up when we discussed education. The Soviet educational system, and its record is pretty impressive, is in his opinion the result of a national philosophy. Immediately after it came to power, the Soviet government placed a tremendous emphasis on the importance of science and technology for society. Accordingly a wide network of polytechnics, specialised colleges and universities grew up within the educational framework drawn up by the state. In contrast, in Britain and the USA, our educational establishments have developed over the years in response to different situations at different times. It is difficult now to draw the threads together under the single educational programme that Tokaty believes is necessary, if education is to meet the future needs of society.

Tokaty's total awareness of the problems and dangers of the technological society is coupled with an unusual optimism and belief in the benefits of science. His attitude reminded me of the Bernals of this century rather than of the more contemporary conscience stricken western scientists.

He believes the recent Soviet flights—Lunas 16 and 17 and now Salyut—indicate a tremendous leap forward in the exploration of space. He repeated this phrase "exploration of space" to emphasize the vastness of the whole enterprise, and the very small aspect of the whole which the Moon represents. It is in this respect that he sees the Soviet achievement as a qualitative leap forward. The Apollo project, he was quick to point out, is a supreme scientific and technological project, and the astronauts are extremely brave men, but it is coming to a dead end. It is stations like Luna 16 and Lunokhod which will be the prototypes of the future. Tokaty believes that the Soviet probes now on their way to Mars may easily attempt something similar on that planet's surface to the Luna 16 operation carried out on the Moon.

Lunokhod is the greatest technical achievement in his opinion. It is a laboratory which explores and then communicates its results while on the spot, in contrast to the Apollo programme where men have to go up to the Moon and then return to Earth before analysing their material. At this point Tokaty also came down to earth to point out the direct use that a Lunokhod type vehicle, or a Luna 16 one for that matter, might have here on Earth. It could be used to explore and study inaccessible parts of the Earth—mountain peaks, marsh areas, volcanic eruptions are just a few examples.

He then passed on to Luna 16, which for him is a symbol of the possibility of doing the same job as Apollo at far less cost and no risks. In his estimation Apollo involved some 400 000 people, over 20 000 major contractors and cost about $24 000 million, while Luna 16 cost something like 30 times less and generally involved much less human and material resources. In addition it had no cosmonauts to worry about.

Rescue in space

At this point Tokaty raised the question of rescue operations. What, he asked, would happen to the American or Soviet image if their astronauts were stranded on the Moon because the landing module refused to take off, or if there was some other fatal accident? He believes anything of this sort could have a tremendously demoralising psychological impact on the Western or Soviet world (depending which was involved). And it is not such a remote possibility remembering the near tragedy of Apollo 13 or the Apollo 7 fire.

Tokaty pointed out that the Soviet Union took this into account when it decided some time ago and after a long debate, to concentrate on unmanned exploration of the Moon. This does not mean that manned trips are excluded completely, but they want to be in a position to be able to mount a rescue operation should something go wrong.

He then moved on to discuss the Salyut flight which he emphasized is a very successful orbital station, despite the initial adverse press reports, and now the tragic deaths of the Soyuz 11 cosmo-

nauts. He thinks the major cause of this tragedy must have been associated with the sudden re-entry overloads (up to 4g), which are very dangerous both to life, and vehicle structure, especially for the welded and mechanised joints and certainly for the pressurisation system. He added here that these overloads could have also damaged the power and life supporting systems of the ship, thus explaining why there were no communications after re-entry. Both Soyuz 10 and Soyuz 11 had modified instrumentation, the aim of the Soyuz 10 flight being to test this as well as the new docking device, before Soyuz 11 went up on longer trials. Despite the tragedy Tokaty believes the scientific programme of the Salyut-Soyuz 11 complex was completed and has expanded knowledge significantly. He emphasised that the design philosophy of Salyut and Soyuz remains first class, and believes that more Soyuz transport ships will dock with Salyut though there will probably be some delay.

Fundamental questions

What is the point of such an orbital station? Tokaty obviously sees all sorts of interesting possibilities, not least of which are the economic advantages to the taxpayer. Orbital stations—and platforms—can reduce the number of extremely costly direct launchings from Earth, where thousands of tons of fuel are wasted just in overcoming the pull of gravity. Instead small spaceships, the size of the lunar module, or even smaller, can be assembled on the space station and then despatched to the Moon or to any other places we wish to explore. There are possibilities of weather control, and of searching for mineral deposits particularly fuel resources. It may be possible to carry out some industrial processes better in space where there is a vacuum, for example the production of ball bearings. But perhaps of more fundamental importance, orbital stations will open up a whole new world to the astronomers, who up to now have had to operate underneath a blanket of atmosphere. The orbital station could carry quite simple and cheap telescopes and reduce the need of the very costly giants being built at the moment. Astronomy and the knowledge it brings about the world outside Earth is essential, Tokaty believes, for man to understand himself. One important philosophical question that he cannot escape is the origin of the universe. That is an important thing to find out.

Finally Tokaty mentioned possibilities for medical research in space. Here again he feels fundamental questions are involved. What effect will the rays normally absorbed by the Earth's atmosphere have on the human body? Perhaps they will make us more beautiful, he suggested hopefully. What will happen when gravitation is removed for any length of time? And he concluded by saying that what he would like to see is a human being born in space and undergoing his whole life cycle in a situation of weightlessness—would he have the same shape, or the same mind? The idea obviously fascinated Tokaty.