To Venture Beyond the Atmosphere

The Foundation of the Max Planck Institute for Extraterrestrial Physics And the Roots of West Geman Space Research

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The Max Planck Institute for Extraterrestrial Physics (MPE[1]) in Garching, a small town 35 kilometers north of Munich, ranks among the most important space research facilities in Germany. It contributed to most of the scientific space missions in which the country participated: from early sounding rocket programs; the *HEOS-1* satellite in 1968 and the first German national satellite *AZUR* in 1969; to present missions such as *XMM Newton* and *CLUSTER-II*. To the general public the MPE became best known for developing and operating the *ROSAT* satellite, *XMM's* glorious predecessor, which scanned the X-ray sky from 1990 to 1999.

One of the reasons for the MPE's importance, if not prevalence, for the West German space research community is the fact that it was founded at the very moment when space technology became available for Germany. Therefore, by telling the story of the MPE's birth, this paper also deals with the birth of West Germany's space research in the wake of *Sputnik*. The intention is to describe the historical situation which called for the foundation of such an institution and to examine in some detail the dynamics which finally shaped it.

One important part of the story is something rather peculiar for the (West) German research system: MPE's mother organization, the Max Planck Society for the Advancement of Science (in German: Max-Planck-Gesellschaft zur Förderung der Wissenschaft - or MPG in short). Therefore, a rough sketch of its most important features during the period covered here may be appropriate.[2]

Founded in 1911 as the Kaiser Wilhelm Society (Kaiser-Wilhelm-Gesellschaft or KWG) and re-founded after the Second World War as the MPG, this organization devotes itself to basic research which cannot, or not yet, easily be pursued within the framework of universities. To insure independence, the MPG is legally a private institution but funded almost entirely by public money. Officially, it is not part of Germany's educational system, although almost all directors of the MPG's institutes hold professorial titles and supervise theses of students from nearby universities. All directors of MPG institutes hold the status of "scientific members." Although the position of the president of the MPG is one of the most influential (not only within the MPG but also in German science politics), the MPG is actually controlled by the collective of scientific members. Control is executed by a system of committees, such as the senate and the scientific council. The MPG runs research institutes (some 80 at present) of various sizes and disciplines, distributed all over Germany. The individual Max Planck Institutes -- that is to say, their directors -- are independent in the sense that they are almost completely free to decide on their own research programs. The MPG's central headquarters (General verwaltung) in Munich serves them administratively.

The MPG constantly tries to adapt itself to changes in the world of science. One way of adaptation is to open up new institutes when and where promising new fields of basic research are opening up. As outlined below, this was certainly the case for space research in West Germany at the beginning of the 1960s. The autonomy of the institute directors -- dubbed the "Harnack Principle"[3] -- has a considerable impact on whether or how new Max Planck Institutes are founded. The policy is to establish them in a tailored fashion specifically for some distinguished, though not necessarily established scientist.

At first glance, this is also what happened in the case of the MPE. On May 15, 1963 the senate of the MPG bestowed upon a small research group of some 15 people the status of a third Institute within the Max Planck Institute for Physics and Astrophysics (MPIPA) in Munich. Before that the research group had operated for 18 months as a division of one of the two other sub-institutes of the MPIPA. This group had been headed by Reimar Lüst, who was now also appointed director of the newly founded MPE. Lüst was an internationally renowned scientist, who had just turned forty. However, as will become clear in the course of this narrative, the foundation of the MPE in many ways deviated from the Harnack Principle, with Lüst's role being considerably more complex. In this context it is interesting to note that for Lüst the

foundational directorship of the country's first genuine space science facility was just one step in one of the most splendid careers in German science. In 1969 he became chairman of the National Science Council (Wissen schaftsrat), in 1972 president of the MPG and in 1984 director general of the European Space Agency (ESA). While the dominant role of Lüst (and some other individuals) for the foundational history of the MPE requires some focus on human protagonists, due reference to the relevant political and scientific contexts is essential. In the case of the MPE this context especially features the beginning of the Space Age and the European efforts to join it.[4]

Reimar Lüst in the mid 1960s.
Image courtesy of Jahrbuch de MPG 1968

DEFINING EXTRATERRESTRIAL PHYSICS

In 1998 the MPE employed 335 people, 183 of whom were scientists of all levels. There are six research departments, four of them headed by a director and scientific member of the MPG. One is devoted to theory, another to laboratory investigation of astronomy-related physical processes. However, the bulk of MPE's scientific work is in the observational domain. The space plasma department is active in various types of space-borne measurements of the physical properties of the particles and field pervading the Solar System. The remaining three departments are engaged in instrumentation development and astronomical observations in the gamma, X-ray and infrared/submillimeter range -- i.e. all those parts of the electromagnetic spectrum that are not accessible from the ground.

From this account one may readily infer a definition for "extraterrestrial physics." It is

> physics of processes beyond the Earth's atmosphere that are not accessible by ground-based observations alone.

The instrumentation -- much more than the subject -- distinguishes the MPE from other institutions with research interests in the sky. This instrumentation is flown on a variety of platforms: balloons; sounding rockets; Earth-orbiting satellites; and space probes.

Because "extraterrestrial" is such a tongue-twisting word, it will often be used synonymously here with the word "space research" (Weltraumforschung), although this term is ambiguously used. Sometimes "space research" applies to space-borne in-situ measurements only, sometimes to all sorts of research done in space. Extraterrestrial physics, however, comprises both measurements of the immediate environment of the instrument ("in-situ") and observations of objects that may be as far away as quasars. Many of those in-situ measurements are aimed at charged subatomic particles interacting with the terrestrial (or solar-terrestrial) magnetic fields, an area of research which traditionally belongs to geophysics. Extraterrestrial physics therefore contributes to both astronomy and geophysics.

PREHISTORY

The Birth of Space Science

Extraterrestrial physics is determined by its means of research rather than its objects. A few years before the MPE came into being, those means suddenly experienced a qualitative improvement beyond measure with the launch of the *Sputnik-1* satellite by the Soviet Union on October 4, 1957. Despite the plethora of political and military implications, the official setting for *Sputnik* was a scientific one (as it was for its ill-fated American rival *Vanguard*).[5] In the years around 1957/58 a maximum of solar activity was expected to increase the intensity and variety of phenomena in the plasma and magnetic fields around the Earth. Only a few of them can be detected from the ground, such as auroras in high latitudes or perturbations of long-distance radio transmissions. Now, in the wake of the Second World War, a new technology was becoming available that promised a new dimension of both warfare and science: rocketry.

After 1945 both the US and the USSR had exploited the know-how of the rocket makers of Peenemünde.[6] Among the first scientific aims of rocketry was to gain knowledge about the higher layers of the atmosphere, the ionosphere and the region where the atmosphere merges with space. This knowledge was badly needed to keep ballistic missiles on their prescribed trajectories. Even before the war was over, Erich Regener, Germany's leading upper atmosphere researcher at the time, had built the first rocket-borne instruments for the *V2* rocket. They were designed to measure densities, pressures and temperatures as well as ionization and UV radiation, but never

flew before the end of the war. In the early 1950s rocketry had made considerable progress. To promote the "peaceful application'' of the new technology during the next solar maximum, the International Geophysical Year (IGY) was proposed for 1957/58 by a group of scientists and welcomed by the governments of the Cold War rivals.[7] In 1955 both superpowers announced the launch of an Earth-orbiting satellite as part of the IGY.

The first American satellite, *Explorer 1*, was launched on January 31, 1958. It also was the first to perform extra-terrestrial research. *Sputnik-1* had only carried a simple radio transmitter and *Sputnik-2* (launched November 3, 1957) the dog Laika. *Explorer 1*, on the other hand, was equipped with detectors which allowed James van Allen to eventually discover the radiation belts -- regions around the Earth where charged particles are trapped by the Earth's magnetic field. Technological advance thus provided new research tools and the Cold War created an environment in the US which was beneficial to space science. Not only was Congress now willing to spend serious money on space. The newly founded NASA took over from rival military services or traditionally private realms of research. NASA provided a firm institutional setting for effectively turning taxpayers' money into technological innovation, scientific progress and national glory.

France and Britain, the other two prospective nuclear powers, also joined the space club, but to a considerably lesser degree. With the help of former Peenemünde technicians and initially for military use, the French developed the *Veronique*, a liquid-fueled sounding rocket with which an extensive program of upper atmosphere research was undertaken during the 1950s. That was about all until Charles de Gaulle returned to power in 1958, resolved to equip France with an independent nuclear capability. Great Britain, unlike Germany, France, the US and the USSR, was a nation without any pre-war tradition in rocketry. Nevertheless, the British soon began the development of their own ballistic missile, the infamous *Blue Streak*, in support of their nuclear weapons program. Scientific interest in space in the UK was stimulated by a conference in Oxford in August 1953, where Sidney Chapman acquainted his countrymen with the American activities and the prospects these would have for geophysics, a traditionally strong field in the UK.[8] This spurred the development of a British solid-fueled sounding rocket, the *Skylark*, which was first tested in 1957 in Woomera, Australia.

Max Planck Society's leading men at the end of the 1950s: President Otto Hahn (left); Ludwig Biermann (center background); Werner Heisenberg (center); and Ernst Telschow (right), MPG's influential secretary general. The picture was taken on the celebration of Max Planck's 100th birthday on April 23, 1958.
Image courtesy Archive of the Max Planck Society

Despite the "peaceful application'' rhetoric, space research depended on military technology. Therefore, international scientific cooperation in an institutionalized fashion was not easily established. But the Soviet success and the subsequent reorganization of American space research changed the political context considerably. In October 1958 the International Council of Scientific Unions (which included scientists from the Soviet Union and its allies) established the Committee on Space Research (COSPAR). It still took COSPAR a full year of negotiations to come into operation. But when the first COSPAR Space Science Symposium took place in Nice in January 1960, space scientists eventually had their international platform.

The Situation In West Germany Before 1959

It was only now that West Germany became involved.[9] Unlike the other countries mentioned, there was no national space activity of any kind until well after the *Sputnik* shock. This was, of course, a direct consequence of allied research restrictions imposed after the destruction caused by the *V-2* missiles during the war. Rocket-related research was much harder to resume than, for instance, nuclear research. After all, the physicists who had remained in National Socialist Germany after the beginning of the war had never built an A-bomb nor even succeeded in achieving a self-sustaining chain reaction in a nuclear reactor. Despite allied control law No. 25 and subsequent regulations, resuming non-military nuclear research was discussed as early as 1952.[10] When the Paris Treaty of May 1955 allowed the Federal Republic of Germany to develop nuclear technology for peaceful purposes, a special Federal Ministry of Nuclear Affairs was set up the same year. Yet rockets remained a tacit taboo, even though the Paris Treaty allowed the Germans to resume rocket research, provided, however, they didn't construct guided missiles with a range greater than 70 km.

The terror of the *V2* missiles was, of course, well remembered. London alone had been hit by some 1200 of them during the last winter of the war, 2700 people had been killed there and another 6500 injured. *V2* strikes were less destructive than conventional area bombings, but since the missiles flew very high before hitting the ground with three times the speed of sound, the lack

of any chance for premonition caused a "stultifying psychological impact."[11] This legacy of war was the major obstacle to any officially coordinated space research activity in West Germany during the 1950s. It also prevented the involvement of an interested military sector that might have spent money on space technology. In a preface to a 1960 study report on space science in Germany conducted by the Deutsche Forschungsgemeinschaft (DFG -- the central public funding organization for academic research in Germany) the authors wrote: "In the Federal Republic we face not only the problem that space research requires large amounts of money and scientific resources, but also the psychological difficulty that it is based on rocketry."[12] When it came to rockets, the Adenauer Administration kept as low a profile as possible.

There was some upper atmosphere research done in West Germany in the 1950s, but rocket-related space research did not exist, with the exception of two flights in 1954, when German instruments flew on French *Veroniques*. These instruments had been built by German scientists based in the former French sector (one of the four sectors that Germany was divided into by the allies after the war): Erich Regener of the Institute for Stratospheric Physics (in Weissenau); Karl Rawer of the Ionospheric Institute (in Breisach near Freiburg); Karl-Otto Kiepenheuer of the Fraunhofer Institute for Solar Research (in Freiburg); and Hubert Schardin of the Institute for Ballistic Research (St. Louis in Alsace). The contacts obviously had been made considerably below the political level.

Hands Across The Sea (1959)

The situation changed in 1959. In September of that year the German Federal Ministry of Nuclear Affairs, which basically served as a department of research, approached Werner Heisenberg (1901-1976). Heisenberg was the director of the MPIPA in Munich and certainly the most prominent figure in post-war German physics. He was advisor on nuclear issues to Chancellor Adenauer[13] and chaired a number of important committees. One of them was the Arbeitskreis Kernphysik (Nuclear Physics Working Panel), a subcommittee of the Deutsche Atomkommission (German Nuclear Commission), responsible for deciding on funding in nuclear science. Heisenberg was not an expert in space research, although he was scientifically interested in some of its aspects, notably cosmic rays. This interest was guided by the high-energy reactions of elementary particles. Before the advent of large accelerators, these were only observable in the interactions of cosmic rays with the Earth's atmosphere.

The federal government proposed to Heisenberg that the Arbeitskreis Kernphysik should now also consider space research.[14] However, the idea that West Germany should now enter the Space Age was not born in Bonn, but in Washington. There, *Sputnik* had considerably altered the attitude towards international collaboration in space. At the NATO summit in December 1957 a scientific committee was established and the European member countries were encouraged to conclude agreements with the US to launch satellite experiments on American launch vehicles. However, the obvious political and military interests articulated here prevented unanimous approval in the international scientific community. Instead, NATO's commendations helped trigger self-organization among the space scientists, notably the foundation of COSPAR and the initiative of physicists Pierre Auger and Edoardo Amaldi to establish a European Space Research Organisation. It therefore took the civilian NASA, founded in October 1958, and its skilled appointee for international affairs, Arnold Frutkin, to initiate cooperation between the US and scientists abroad.[15] In 1959 NASA officials began to tour Western Europe, offering American support to its space scientists.

NASA's representatives also came to Germany. For instance, on the occasion of a conference in Aachen in September 1959, Hugh Dryden and Homer Newell of NASA asked for a conversation with Walter Dieminger (born 1907), the director of the Institute for Ionospheric Research of the Max Planck Institute for Aeronomy (MPAe). They told him that the US would be willing to fly West German experiments on American rockets or satellites.[16] These offers triggered West Germany's entry into the Space Age. The Max Planck Society, Heisenberg's institutional home, felt especially encouraged to go space-borne. Here the largest share of the tiny West German extraterrestrial community was based. Experimental space research was done there at the two institutes in Lindau which together formed the MPAe: Dieminger's Institute for Ionospheric Research; and the Institute for Stratospheric Physics, headed by Erich Regener's successor Julius Bartels (1899-1964), a renowned geophysicist.[17] Theoretical space science was covered by the Institute for Astrophysics (IAP) in Munich, a subinstitute of Heisenberg's MPIPA. Its director, Ludwig Biermann (1907-1986), was internationally perhaps the most respected of all German astrophysicists. In 1951 Biermann had interpreted observations of the plasma tails of comets in terms of a strong efflux of particles from the Sun.[18] The American theorist Eugene Parker dubbed this efflux "solar wind" and interpreted it as a continuous expansion of coronal gas. The existence of the solar wind was eventually confirmed in 1959-1962 by direct measurements performed by the *Luna-2*, *Explorer-10* and *Mariner-2* space probes.[19]

TOWARDS THE FOUNDATION OF THE MPE

The MPG's First Steps Into Space (Late 1959 And Early 1960)

Over the Christmas holidays of 1959 the Minister of Nuclear Affairs,

Siegfried Balke who lived in Munich, met Heisenberg and Biermann to talk about space research within the MPG. However, three months after Dieminger had met the NASA officials in Aachen in September, the matter must already have been discussed to some extent within the MPG, at least informally, without leaving written traces. This conjecture is suggested by the fact that a fairly elaborate concept was already available when the Christmas chat now triggered immediate action. On Wednesday December 30, 1959 the three directors of space-interested MPIs, Biermann, Dieminger and Bartels, wrote a letter to MPG president Otto Hahn.[20] In this letter they proposed that their three MPIs should form a "Working Group for Extra-Terrestrial Research Within the MPG.''[21] This working group would do the necessary preparatory work to set up a new research group at the MPIPA in Munich. The location issue had already been settled at this point: "Those of the three involved who are not based in Munich, do favour the working group to be located in Munich.'' In the first three years the directors of MPAe and IAP of MPIPA were supposed to set up the extraterrestrial budget together. The idea was to assign some five scientists and eight technicians to do research with the "new research tools,'' that is to plan and build scientific instruments to be flown on rockets and satellites.

The research topics specified were the ones being undertaken abroad at the time, especially in the US. Topping the list were the radiation belts, cosmic rays and their interaction with the terrestrial magnetic field, an area Biermann's institute had already been working on theoretically. Others were solar activity, X-ray and UV astronomy, research of the upper atmosphere with small sounding rockets and turning raw data obtained by (foreign) satellites into information usable for scientists. This reads like an account of the research fields later covered by the MPE in the mid-1960s and after, although weights shifted considerably. However, the founding fathers were not quite explicit where actually to start. For the time being, 100,000 DM in the first year and a wooden cabin in Garching to work in were considered sufficient.[22]

This letter of Biermann, Dieminger and Bartels to Hahn actually is the initial document of the MPE. Five days later, on January 4, 1960, the three met Hahn and the issue was immediately settled. At its next meeting in March 1960 the senate of the MPG passed the bill with only two changes: funds were slightly increased; and the Max Planck Institute for Nuclear Physics (MPK) under Wolfgang Gentner (1906-1980) joined the team.[23] All that existed so far was a working group of five high-ranking elderly Max Planck directors (Bartels, Dieminger, Gentner, Heisenberg, and Biermann) eager to promote a new field, but no research group to do the actual science.[24] Indeed, manpower was even more a problem than money. Above all they needed someone to head the new research group. Due to its decade-long absence, Germany had nobody with enough experience in the state-of-the-art hardware and organizational issues of extraterrestrial research. There was, of course, considerable experience in places like Pasadena, Iowa City or Chicago, but who would leave a thriving "researchscape'' to head a small group of people in a cabin in Garching? Biermann -- always in close touch with Heisenberg -- took the initiative.

Biermann and Lüst (1959/60)

Biermann seemed to have the clearest idea of what the new research group should look like. It should be experimental, but with strong ties to theory, especially plasma theory. He was the one who had found the first evidence for interplanetary plasma and that was the sort of thing he was interested in up there.

This is when the 36-year old Reimar Lüst entered the stage. Lüst (born 1923) was a theoretical astrophysicist by training. He had received his PhD in 1951 at Göttingen University as a student of Carl Friedrich von Weizsäcker (who himself had been a student of Heisenberg) and spent 1955/56 as a Fulbright Fellow at the Enrico Fermi Institute of the University of Chicago and at Princeton. In Chicago he had worked with John Simpson. Together with his Chicago colleague Eugene Parker and experimentalist James van Allen in Iowa,[25] Simpson was one of the doyens of a new branch of science at the intersection of nuclear, plasma and geophysics: the interaction of cosmic rays with the terrestrial magnetic field. Lüst had become interested in the theoretical aspects of this research field already after his PhD.

However, after Lüst came back from the United States in early 1957, he somewhat (but not entirely) shifted his research to fusion plasma physics -- a very promising field in those days, especially within the MPG, where discussions of what later became the Max Planck Institute for Plasma Physics (IPP) had started in 1956. Having held several other posts within the Max Planck Society earlier in the 1950s, Lüst was promoted to group leader for astrophysical plasmas at the Institute for Astrophysics in September 1958. In 1959 he accepted an invitation to lecture at New York University as a visiting professor for mathematical physics at the Courant Institute. During this stay in New York City, Lüst received no less than three job offers -- one more tempting than the other -- to Rochester, New York and the new Nuclear Research Center in Karlsruhe. Biermann, however, was not particularly pleased. He needed Lüst as a leading plasma expert with a strong astrophysical background, now that fusion plasma physics began to dominate the MPIPA. But the only way to keep Lüst was to promote him again. Biermann could not offer him a professorship, but, backed by Heisenberg, offered him scientific membership in the MPG. This was just as good from the financial point of view and almost as good for his reputation.[26]

In July 1959 Biermann and Heisenberg jointly wrote a letter to Lüst. After mentioning the progress made towards a plasma fusion research lab in Garching, they wrote:

> Naturally, this means that the importance of plasma physics won't decrease at the Institute for Astrophysics -- although it is planned to do theoretical work concurrently also in Garching. In order to keep a reasonable balance with regard to astrophysics in the narrower sense, it is intended to assign to you to the position of division leader at the Institute for Astrophysics... We also would immediately, i.e. as soon as we know that you will stay with us, apply for your appointment as a scientific member of the institute. Considering the situation, there is obviously no doubt that this application will be accepted ...you would be responsible primarily for the field of theoretical astrophysics -- although you are of course free to contribute to theoretical plasma physics as well, as you have done so far. The particular concern of the one of us (B.) (sc. Biermann) naturally is that theoretical astrophysics, which was the basis of all the other developments at the Institute for Astrophysics, will again become stronger after the fast expansion especially of plasma physics...[27]

Interestingly, the application letter to president Otto Hahn soliciting Lüst's scientific membership was delivered with a slightly different pitch. There Biermann and Heisenberg wrote: "Considering the importance to which the area of plasma physics has grown also in our institute in the context of fusion, we feel that especially now it would have been a great loss if Herr Lüst had left us.''[28]

It helped. With the prospect of scientific membership, Lüst declined all other offers, returned to Munich and finished his habilitation in January 1960. Soon after, Lüst was offered another chair, this time at Utrecht University, which he also declined. Reimar Lüst was appointed scientific member on March 16, 1960 and shortly afterwards was also promoted to division leader for astrophysical plasmas, which resulted in a higher salary than his previous position as group leader. His appointment as a scientific member of the MPG came on the very day that the "Working Group for Extra-Terrestrial Research Within the MPG" was approved, although there was no connection between the two yet at this point. However, during the year 1960 two developments, one prominent and political, the other inconspicuous and scientific, jockeyed Lüst into Biermann's and Heisenberg's plans for observational extraterrestrial research.

Lüst In Space (1960)

The political development concerned Europe. The first calls for European cooperation in space had come not long after the *Sputnik* shock prompted the US to look for collaborators in space among its NATO allies. An obvious model for a joint European space project was the nuclear research center CERN near Geneva. There a 25 GeV proton synchrotron had just reached its design energy in November 1959, providing European scientists with the world's most powerful accelerator and demonstrating that European collaboration could work. This was fortunate timing for Pierre Auger and CERN's Edoardo Amaldi. The two physicists, one French, one Italian, together had hatched the idea of setting up a European Organization for Space Research in the spring of 1959. Now the time was ripe for their plans to surface at the first COSPAR Space Science Symposium in Nice, France in January 1960.[29]

Nice triggered a series of meetings among the most senior people of the European space-interested scientific community: Pierre Auger from France; Henk van de Hulst from Holland; Edoardo Amaldi and Luigi Broglio from Italy; and Sir Harrie Massey from the United Kingdom, to name just some of the most prominent ones. West Germany was initially represented by Julius Bartels. Bartels, the director of the Institute for Stratospheric Physics of the Max Planck Institute for Aeronomy, was a distinguished figure both in the MPG and internationally. He attended the Nice symposium and the subsequent informal meeting at Auger's apartment in Paris and was invited to the first "official'' talks among European space researchers to be held in London on April 29, 1960. However, Bartels was preoccupied with the directorship of his institute and a chair at Göttingen University and also was heavily involved in analyzing data obtained during the International Geophysical Year. Having no time to seriously become engaged in the European enterprise, he sent his deputy Alfred Ehmert to London instead, who reported from the meeting to the working group.

In early October 1960, when the scientists' discussions had definitively reached the political domain, the Royal Society in London hosted a meeting of a technical working group to prepare intergovernmental talks on how Western Europe could coordinate its efforts in space. Now West German scientists were needed to represent their country in serious political negotiations. Again, Bartels sent Ehmert, but Lüst was also chosen to go.

At first sight the choice of Lüst seems a little strange, since he did not have any experience preparing him for the job, neither in space-related technology nor in international science management. He was, in his own words, "a complete newcomer.''[30] However, the young theoretician had obviously attracted the necessary attention in the summer of 1960, when three gentlemen from the Deutsche Forschungsgemeinschaft (DFG) paid a visit to the MPIPA in Munich. Gotthard Gambke, Rudolf Kerscher and Walter

Kertz were surveying the West German scientific community in preparation for the earlier mentioned DFG study report titled "Memoir on the Situation of Space Research in the Federal Republic of Germany."[31] The DFG had been asked for this stocktaking by the German federal government in July 1960. The memoir was explicitly ordered as the basis for the negotiations at the London meeting in October. Gambke, Kerscher and Kertz also interviewed Lüst, the leader of the institute's division for the theory of astrophysical plasmas, and eventually included him in the advisory committee. Its fifteen members discussed the final version of the study report on September 27, 1960. Apart from Kertz, Lüst was the only non-senior scientist in this committee, which otherwise comprised only Max Planck directors and chair-holding full professors. A few days later, at the request of the DFG, he accompanied Ehmert, Gambke and Kerscher to the London meeting as a German scientific delegate. Obviously, Heisenberg and Biermann welcomed this very much.

Biermann's Dream (1960)

The fact that Biermann approved of his leading expert for astrophysical plasma theory practicing politics is less surprising if one considers that the situation had changed considerably since late 1959. Fusion plasma physics now definitively had its own home in the Institute for Plasma Physics, founded in June/July 1960, as a result of which Biermann's Institute for Astrophysics could now again exclusively focus on astrophysics. Moreover, the prospect of extraterrestrial research had a considerable impact on Biermann's own research interests as well. In 1960 Biermann had worked out an idea on how to directly probe the solar wind. A spacecraft could be used to carry a payload consisting of a certain alkali metal into interplanetary space. Once the metal is vaporized by a sufficient exothermic chemical reaction, the solar radiation would photo-ionize the metal atoms and excite the ions, making them visible in optical wavelengths and therefore observable from the ground. This "artificial comet'' would then trace the magnetic field carried by the solar wind and reveal its structure and behavior. In 1961 a paper with detailed calculations was published by Biermann, Herrmann Ulrich Schmidt, Reimar Lüst and his first wife Rhea, who was an astronomer and expert on comet tails.[32] The major part of the work was done during 1960 and showed that the idea should work with just a few kilograms of metal.[33]

This was to be the first project of the yet to be created extraterrestrial research group. It was new, but comparatively inexpensive. It was simple, but theoretically interesting, "good science, no instruments on board but a strong box filled with cheap chemicals, and spectacular phenomena in the event of success."[34] Moreover, it was plasma physics and it was in space -- thus eligible for the funding now available. The final goal, however, was interplanetary space, which could only be reached with the most powerful launch vehicles of the time. A special relationship between the projected extraterrestrial research group and the political levels which would ultimately have to provide the means to make the artificial comet shine was therefore very desirable. Since Lüst was involved both scientifically in Biermann's promising idea and politically in Europe's space efforts, he became a key figure in the MPG's extraterrestrial endeavor. His excellent connections with the United States were another plus. But there was a problem; Lüst was a theoretician with no experience in hardware issues.

Waiting For Peter Meyer (1960-61)[35]

Because hardware was to become the daily bread of the new group, Lüst

Peter Meyer, around 1979.
Image courtesy of Archive of the Max Planck Society

was not particularly qualified to lead it. Instead, Biermann and Heisenberg saw him and his division at the IAP as a sort of a theoretical partner to the leader of the planned experimental extraterrestrial group. The leading candidate for that post was Peter Meyer, an old friend of Lüst's from his days at Göttingen University. Meyer was a former postdoc at the MPI for Physics, who went to John Simpson's Institute at the University of Chicago in 1951. There he became very active in constructing detectors for cosmic ray research. Biermann and Lüst approached Meyer, who visited Munich in the summer of 1960. One result of their talks was a more realistic estimate of the funds which the extraterrestrial group would need: at least one million DM a year, plus another million for a proper laboratory building in Garching. Minister of Nuclear Affairs Siegfried Balke was "not shocked'' as Biermann reported these numbers to him. Hopes of getting Meyer to Garching rose.

Meyer, however, hesitated, despite the fact that the annual budget was raised to three million DM and

Heisenberg made sure that Meyer would be appointed scientific member with the conditions of a full professor (Ordinarius) as soon as he came. The negotiations carried on well into 1961, but Meyer never came. His letters to Biermann and Lüst display two reasons why he eventually declined the offer. First, Meyer's wife held a good position as a physicist in the Argonne National Laboratory and would not have found any comparable employment in Munich. Second, Meyer suspected that the European efforts to invest in a "not very promising'' launch vehicle development program would eventually swallow up all the money, leaving too little for scientific payloads. This danger was quite real. In 1960 the British had begun to talk other European countries into carrying out a joint launch vehicle project. They wanted their enormously expensive *Blue Streak* missile, which as a liquid-fueled rocket had turned out to be militarily useless, to become the first stage of a European satellite launcher.

The effort to get Meyer only delayed things. Meanwhile, European space efforts had gained momentum. COPERS, a preparatory commission for the planned European Space Research Organization (ESRO), the forerunner of today's ESA, had been established at an intergovernmental conference in Meyrin, Switzerland at the end of 1960. At its first meeting in March 1961 Reimar Lüst was elected coordinating secretary of the scientific-technical working group. He was nominated for this position by COSPAR's president Henk van de Hulst, who had been involved in offering Lüst a chair at Utrecht University in early1960.

Soon, Lüst and his British counterpart A.W. "Freddy" Lines (who later became ESRO's first technical director) were assigned to draft ESRO's future satellite program.

At the same time the European launcher issue became a subject of fierce debate within the West German government.[36] The emerging German space industry, notably Ludwig Bölkow,[37] demanded that any European effort had to be accompanied by a strong national space program in order to become an equal partner in the projected European Launcher Development Organization (ELDO). The German space scientists thoroughly agreed. Many of them soon shared Meyer's fears that the country's European devotion would eventually drain their very resources. The expected German contributions to both ELDO and ESRO for 1962 were initially estimated to be 55 million DM. That the government should additionally spend at least twice that amount on national space research projects became the scientists' mantra for the years to come.

Being both a witness to and a participant in the discussions on Europe's space efforts, Lüst realized that it was high time to establish a space science infrastructure on a national level where these requested financial resources could be effectively allocated. An important piece of this infrastructure was the extraterrestrial group in Garching. The situation called for immediate action. Following a list Meyer had given him earlier, Lüst started buying equipment and looking for people to employ. In doing so Lüst grew into a new role. In September 1961, at which time Meyer had not yet finally declined, Biermann wrote to Heisenberg:

"Even if he (Meyer) accepts, I would like to give Lüst a larger share of the responsibility for the extraterrestrial research than previously intended.''[38]

There was also another reason for Biermann to improve Lüst's position. Lüst had been offered the position of Co-Chairman of the Department of Space Research at Cornell University and shortly afterwards a professorship at the California Institute of Technology (Caltech). By now (late 1961) Lüst was the principal scientist representing West German space interests on the European stage. If he left for America, this would cause severe damage, not only to the Institute for Astrophysics, but to the whole West German space community. Biermann had to do act quickly.

He knew that Lüst would be interested in a professorship at the University of Munich (LMU) in combination with his position at the Max Planck Society, but only if he could get access to Diploma students. When Heisenberg approached Fritz Bopp, the head of the theoretical physics division at LMU, Bopp didn't like the idea. A Max Planck scientist supervising Diploma theses and thereby luring young people away from the university institutes was definitively not in his interest. Heisenberg's efforts to provide a professorship for Lüst remained futile for the time being.

Die Abteilung Lüst (late 1961-spring 1963)

In the late autumn of 1961 a group of six people, three of them scientists, eventually took up work in the Garching cabin,[39] with Lüst having the sole responsibility. Informally known as Die Abteilung Lüst (The Division Lüst), it was first referred to in an important memo dated January 16, 1962, which was signed by both Heisenberg and Biermann.[40] This memo probably was the result of a conversation of Heisenberg and Biermann with Lüst, in which the latter had apparently convinced them of the need to eventually turn the division into a Max Planck institute. Heisenberg and Biermann declared in a rather circumstantial and fuzzy way:

> In case of a favourable development of the division - to be headed by Herr Lüst - in respect of instrumental development and staff set-up, the signatories will pursue the conversion of the division of extraterrestrial research into an institute within the Max Planck Institute for Physics and Astrophysics. Herr Lüst shall obtain contractual warranty that he may work in an American institute once every two years for a

period up to six months, provided a substitute can be arranged.[41]

An explicit proposal for a separate institute had not even come up during the negotiations with Peter Meyer, who might have been more inclined to accept the offer if the directorship of such an institute had been at stake. That Meyer had never raised the issue himself can be seen as further evidence that he never really wanted the job. That Biermann or Heisenberg had never raised it either shows that they did not yet consider extraterrestrial research important enough to justify the creation of a separate institute. Their reluctance to share power with a third director within the MPIPA -- even with an experimentalist such as Meyer -- may have been another factor. Even in mid 1962, less than a year before the MPE was actually founded, Heisenberg was not completely enthusiastic about the idea. In the MPG administration Heisenberg was quoted merely to consider a "step-by-step realization'' of Lüst's plans appropriate.[42]

Lüst, however, thought otherwise. In the beginning he had supported the idea of an inter-institutional working group of the MPI for Physics and Astrophysics, the MPI for Aeronomy and the MPI for Nuclear Physics. Since extraterrestrial research didn't deal with new science but rather with new means of conducting science, he argued in the summer of 1960 that the MPG should "not yet establish a new institute, but intensify and, when required, expand the efforts of those institutes which are already interested in such matters."[43] But now he knew from his European experience that space research was technologically and organizationally too complex an enterprise to exist as an appendage to a theoretical institute. This explains his boldness in asking Heisenberg and Biermann to eventually turn the Abteilung Lüst into a separate institute (an idea which they are not likely to have thought up themselves). He probably didn't care too much that this meant turning the Harnack Principle somewhat upside down. After all, the Harnack Principle implies that the MPG builds an institute around a distinguished scientist, not that a scientist makes the MPG build an institute around him, as was the case here.

The MPE cabin in Garching near Munich 1961/62. The cabin hosted offices and laboratories of the extraterrestrial research group until a first proper builing was erected in 1965. It was destroyed by fire in 1970.
Image courtesy of MPE

The MPG administration obviously didn't have a problem with this procedure either, although it surely expected some time to pass before the "favourable development of the department'' would allow Lüst's goal to be fulfilled. What they did have a problem with was the general leave of absence once every two years. This matter, however, soon became obsolete, when Lüst's ever intensifying European duties (in 1962 he also became chair of the COPERS launching program subcommittee) made it impossible for him to accept any more visiting professorships in the US. The last ones he accepted before becoming director of the MPE were at MIT from September to December 1961 and Caltech from January to March 1962. Considering that Lüst was now in charge of a research group literally under construction, it is most surprising that he was hardly present in Garching for longer periods of time.

Nevertheless, within less than a year, Lüst's group assembled its first scientific payloads. These were ion cloud experiments inspired by Biermann's artificial comet idea. The initial experiments consisted of burners filled with a mixture of powdered aluminium and barium peroxide. In November 1962, two were carried by French *Centaure* rockets from the Ile de Levant in the Mediterranean.

Why France? What had become of NASA's generous offer to fly German equipment on US spacecraft? For one thing, huge space rockets or even satellites were not needed for these kinds of experiments at such an early stage of development. Before any artificial comet payload could be mounted on an expensive launch vehicle, the technology of generating ion clouds had to be developed and thoroughly tested in the more easily accessible parts of space right above the Earth's atmosphere.[44] Of course, this region was known to be well within the boundaries of the magnetosphere, meaning that no solar wind could actually be probed. But the ion clouds were expected to trace the terrestrial magnetic field instead -- and probably that wasn't altogether uninteresting either.

In other words, there was no need for heavy American launch vehicles for the time being. Smaller and considerably cheaper rockets were available from the French and they -- apart from being closer -- were also quite generous. The first rides of the Garching barium burners on the *Centaures* were free of charge. This was courtesy of Jacques Blamont, Scientific and Technical director of the newly founded Centre National d'Etude Spatiales (CNES) and a sounding rocket expert, who had performed the French atomic sodium cloud experiments with the *Veronique* in 1959. Lüst had first met Blamont on the occasion of his European debut at the London meeting in October 1960. When he told him of Biermann's ion cloud idea, Blamont offered piggyback rides on the French rockets.

Unfortunately, the two November 1962 launch attempts were not successful. Due to engine failures both rockets had to be destroyed shortly after launch. However, Lüst's people (15 by January 1963 -- among them five scientists) had made their first step in the extraterrestrial business.

The "Little Institute'' (May 1963)

Biermann's battle to keep Lüst in Garching was not all over yet. In 1962 Lüst once more received an offer for a prestigious position, this time a chair for theoretical astrophysics at Göttingen University. It is hard to say how seriously he considered it, but he did make substantial efforts to negotiate on the financial endowments of his chair in Göttingen.[45] However, this effort eventually paid off, since it obviously caused the Max Planck officialdom to procure Lüst with his own little MPI much earlier than one would have expected. Before anyone could judge the "favourable development'' of the research group based on scientific results (not to mention publications), Heisenberg wrote to MPG president Adolf Butenandt in January 1963.[46] Stressing Lüst's recent offer from Göttingen, he urged Butenandt to take measures to promote the extraterrestrial department to a third institute within the MPIPA on the next possible occasion, which was the 1963 general assembly of the MPG in Augsburg. Naturally, Lüst was the one and only candidate for the position of director.

Appointing an MPI director had become a time-consuming procedure just two months before, when the MPG senate had agreed on a two-stage procedure. First, senators were informed about the candidate. The final discussion and appointment of the candidate took place in a later session in order to allow enough time for the invitation and discussion of expert opinions on the candidate's scientific and personal qualifications. In Lüst's case, this scheme was readily abandoned. Butenandt himself proposed to appoint Lüst within one session. Also, Carl Wagner of the MPG scientific council could not see any need for outside expert opinions on Lüst, considering the pending offer from Göttingen and the latest news from Paris, where Lüst was asked to become scientific director and deputy director general of ESRO.[47] But it was clear to everybody what the reason for the hurry was. As is mentioned in the proceedings of the meeting: "The gentlemen Heisenberg and Biermann have asked to speed up the procedure in order to assure Herr Lüst's remaining within the MPG.''[48] On May 15 the senate approved the creation of the MPE. A popular MPE anecdote relates that after the session Butenandt left the hall where the senators had been meeting and on seeing Lüst exclaimed: "Da haben Sie Ihr Institütchen.'' ("There you have your little institute.'')

The French *Centaure* sounding rocket in Hammaguir, Algeria, November 1965. The person on the left is MPE's chief chemist Hermann Foeppl.

Image courtesy of MPE

On that very day the institute's first successful experiment flew from a French military launch pad near Hammaguir in the Algerian desert. This time the *Centaure* rocket worked and a load of barium was evaporated to form a cloud at a height of 155 km. This was not yet an ion cloud (those were produced a year later) and it was far from being in interplanetary space. It took another 20 years for Biermann's dream of an artificial comet to come true. The creation of an artificial comet beyond Earth's magnetosphere was finally accomplished with the MPE's *Ion Release Module*, flown on the *AMPTE* mission in December 1984.[49]

CONCLUSION

The MPE is an early German product of the Space Age. The Second World War had boosted the development of rocketry, a new technology which first remained reserved for the winners of the war. Then the *Sputnik* shock promoted a considerable shift in the political context. Rockets and satellites now became Cold War weapons, too. The US allowed limited proliferation of space technology from the classified military domain into civilian science. This change of policy gave German researchers access to the technological means of performing scientific research beyond the atmosphere. In 1959 NASA offered launch opportunities to German scientists, but Germany's capabilities in this field were not yet sufficient to immediately accept that offer. The MPG provided a suitable institutional framework for establishing such a capability for three reasons. First, it was part of its policy to deal with newly emerging fields of science too difficult to cope with at the universities. Second, because the largest share of the few space-related activities in Germany was already domiciled in MPIs. And finally because of Werner Heisenberg.

Heisenberg was a key figure in science politics in the early Federal Republic of Germany. Alhough he was not an expert in space science to the same extent as in nuclear or elementary particle physics, Heisenberg committed himself to promoting the new field. His

Reimer Lüst in Bidon, Algeria at MPE's second rocket campaign in the Sahara Desert in February 1964.

Image courtesy MPE

fellow director of the Institute for Astrophysics in Munich, Ludwig Biermann, took a special professional interest in the new research possibilities. This situation triggered the plan for a coordinated extraterrestrial enterprise among a group of senior MPG scientists led by Heisenberg and Biermann. Since the new technology was promising also for other disciplines represented in the MPG, the enterprise started as a collaborative effort between three MPIs. However, the unanimous decision to locate the new activity in Munich suggests that Biermann and Heisenberg dominated the discussion from early on.

From the very beginning, the MPG's extraterrestrial enterprise was defined by its means rather than its subject. Since these means were rockets and satellites provided from abroad, any such project had to be managed both at MPI level and in international collaboration. Therefore, a staff leader of the planned extraterrestrial group should ideally match three criteria: expertise in experimental space research; compatibility with the MPIPA; and superior international connections. The young theoretician Reimar Lüst satisfied two of these criteria perfectly. He was a home-grown Max Planck physicist on best terms with Biermann and Heisenberg. Lüst also had spent more than a year in John Simpson's research group at the University of Chicago, definitely one of the hubs of early space physics.

Afterwards, he succeeded in maintaining and expanding his personal American connections, which certainly contributed to the numerous offers he received for faculty positions at choice universities. When he became involved in European space efforts in October 1960, he quickly extended his network to London and Paris.

Lüst therefore belonged to two networks at the same time. Because he was part of the "inner'' MPI network, he became part of Biermann's and Heisenberg's extraterrestrial plans. His participation in Biermann's artificial comet idea was his initial scientific step towards experimental space research. His connections in the "outer'' international network, however, drove the dynamics of the foundation of the MPE. Not only was the pace considerably accelerated by the frequent offers which Lüst received from abroad but he also knew from his international experience that there soon had to be some real West German space science activity if the country was to be on an equal footing with England, France and Italy in the emerging European Space Research Organization. This encouraged him to actively embark on the formation of the Garching research group while the negotiations with Peter Meyer were still pending. The very fact that Lüst dealt with the MPG's extraterrestrial project from an international perspective therefore enhanced his commitment for this project and eventually formed its final -- and finally successful -- institutional setting.

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The author made the following interviews for the article:

- Reimar Lüst, March 30, 1999 in Hamburg;

- Gerhard Haerendel, April 13, 1999 in Garching;

- Jakob Stöcker, April 14, 1999 in Garching; and

-Walter Dieminger, November 11, 1999 in Northeim.

REFERENCES

[1] Until 1991, when the Max Planck Institute for Physics and Astrophysics (MPIPA) became separated into three legally independent institutes, MPE's official name was "Institute for Extraterrestrial Physics at the Max Planck Institute for Physics and Astrophysics'' (IEP at MPIPA). But the handy abbreviation MPE was used from early on. For briefness, MPE is used here also for the institute before 1991.

[2] These features basically still prevail, albeit with modifications. For a comprehensive chronicle of the post-war MPG see: E. Henning & M. Kazemi, *Chronik der Max-Planck-Gesellschaft zur Förderung der Wissenschaften 1948-1998*, (Berlin: Duncker & Humblot, 1998). Also see: B. vom Brocke & H. Laitko (eds), *Die Kaiser-Wilhelm-/Max-Planck-Gesellschaft und ihre Institute: Studien zu ihrer Geschichte: Das Harnack-Prinzip*, (Berlin: Walter de Gruyter, 1996).

[3] After Adolf von Harnack (1851-1930), the founder and first president of the Kaiser-Wilhelm-Gesellschaft. See e. g. R. Vierhaus, Bemerkung zum sogenannten Harnack-Prinzip. Mythos und Realität, in: B. vom Brocke & H. Laitko, Die Kaiser-Wilhelm-/Max-Planck-Gesellschaft und ihre Institute, 129-138.

[4] This topic has already been covered by quite a few studies, notably those published in the ESA History Study Reports series (see http://esapub.es rin.esa.it/publicat /hsr.htm for a complete list of the ESA History Study Reports). An overview from a German perspective is provided e.g. in: H. Trischler, *Luft- und Raumfahrtforschung in Deutschland 1900-1970*, (Frankfurt am Main : Campus, 1992: 285-472). This book deals with air and space research in Germany before 1970 and is part of a whole series of studies on the history of big German science institutes. On the other hand, historical studies of specific Max Planck Institutes are less frequent. The collection edited by vom Brocke & Laitko (1996), for instance, comprises a series of papers on several KWG institutes, but not on Max Planck Institutes after the war. A notable exception is a monograph on the early history of the Max Planck Institute for Plasma Physics (IPP): S. Boenke, *Entstehung und Entwicklung des Max-Planck-Instituts für Plasmaphysik, 1955-1971*, (Frank-furt am Main: Campus, 1991). This has been continued in: I. von Stumm, "Kernfusionsforschung, politische Steuerung und internationale Kooper-ation: das Max-Planck-Institut für Plasmaphysik (IPP) 1969-1981," (Ph. D. Thesis, München, LMU, 1999).

[5] For a recent account of the scientific prehistory of both Sputnik and Vanguard, see: H. Gavaghan, *Something New Under The Sun: Satellites and the Beginning of the Space Age*, (New York: Coper-nicus/Springer, 1998). A more political focus is provided by e. g.: W. McDougall, *...The Heavens and the Earth: A Political History of the Space Age*, (New York: Basic Books, 1985: 74-140).

[6] See for instance: G. Greschner, Zur Geschichte der deutschen Raumfahrt, in: K. Kaiser, S. F. v. Welck (eds.), *Weltraum und internationale Politik*, (München: Oldenbourg, 1987: 255-278) and references therein. For a comprehensive account of how V-2 technology boosted US space science, see: D. DeVorkin, *Science With A Vengeance: How the Military Created the US Space Sciences After World War II*, (New York: Springer, 1993).

[7] The Eisenhower administration in particular. By launching a civilian satellite, Eisenhower planned to establish a precedent which would allow future US reconnaissance satellites to fly over Soviet territory without violating international law. See: W. McDougall, *...The Heavens and the Earth*, 118ff.

[8] P. Willmore, Ionospheric Research By Rockets and Satellites in Europe in the 1960s, in: A. Russo (ed.): *Science Beyond the Atmosphere: The History of Space Research in Europe*. Proceedings of a symposium held in Palermo, 5-7 November 1992, (Noordwijk: ESA HSR Special, 1993: 67-73); H. Massey, M. Robins, *History of British Space Science*, (Cambridge: Cambridge University Press, 1986: 7f).

[9] All the following refers to West Germany only, although the word "West'' is sometimes omitted. For a short account of space research in East Germany (GDR), see: H. Zimmer, Weltraumpolitik der Deutschen Demokratischen Republik, in: K. Kaiser, S.F. v. *Welck (eds.): Weltraum und internationale Politik*, 377-392.

[10] e.g. S. Boenke, *Entstehung und Entwicklung des Max-Planck-Instituts für Plasmaphysik, 1955-1971*, 44f ; H. Trischler, *Luft- und Raumfahrt-forschung in Deutschland 1900-1970*, 286ff and references therein.

[11] D. DeVorkin, Science With A Vengeance, 47. On the history of the V2 missile, see: M. Neufeld, *The Rocket and the Reich: Peenemünde and the Coming of the Ballistic Missile Era*, (New York: The Free Press, 1995).

[12] G. Gambke, R. Kerscher, W. Kertz, *Denkschrift zur Lage der Weltraum-forschung, verfasst im Auftrag der Deutschen Forschungsge-meinschaft*, (Wiesbaden: Franz Steiner Verlag, 1961: 11).

[13] On Heisenberg as scientific advisor in the early Federal Republic, see: C. Carson, "New Models for Science in Politics: Heisenberg in West Germany," *Historical Studies in the Physical and Biological Sciences* 30:1 (1999); Also see: M. Eckert, "Primacy Doomed To Failure: Heisenberg's Role as a Scientific Advisor for the Nuclear Policy in the FRG," Historical Studies in the Physical and Biological Sciences 21:1, 29-58 (1990).

[14] H. Trischler, *Luft- und Raumfah-rtforschung in Deutschland 1900-1970*, 402.

[15] W. McDougall, *...The Heavens and the Earth*, 206-208. For further details and references on the motivation and impact of the American offers, see: J. Krige, L. Sebesta, US-European Co-operation in Space in the Decade After *Sputnik*, in: G. Gemelli (ed.), *Big Culture: Intellectual Cooperation in Large-Scale Cultural and Technical Systems*, (Bologna: Editrice CLUEB, 1994: 263-285).

[16] Dieminger to Heisenberg August 6, 1960 (Werner Heisenberg Archives, Munich).

[17] After Regener's death in 1955, his Institute for Stratospheric Physics was moved from Weissenau to Lindau, where it joined Dieminger's Institute for Ionospheric Research. This double institute was renamed the MPI for Aeronomy in 1957. Lindau is situated near Göttingen in Lower Saxony and is not to be confused with the bigger and better known Lindau in Bavaria.

[18] L. Biermann, "Kometenschweife und solare Korpuskularstrahlung," *Zeits-chrift für Astrophysik* 29, 274-286 (1951).

[19] K. Hufbauer, *Exploring the Sun: Solar Science Since Galileo*, (Baltimore: John Hopkins University Press, 1991: 222-239).

[20] Bartels, Biermann and Dieminger to Hahn Dec 30, 1959 (Werner Heisenberg Archives).

[21] This is the earliest recorded mention of the term "extra-terrestrial'' (the hyphen got lost in the course of 1960). According to a letter of Bartels to Gentner (Oct 5 1960) the word had been coined by Siegfried Balke for political reasons. From 1959 until the establishment of the Deutsche Kommission für Weltraumforschung (the German Commission for Space Research) in 1962 there were ongoing quarrels among several federal departments about who might be responsible for space affairs (see Trischler, 401). The fight was especially fierce between Balke and his cabinet colleagues Seebohm (transportation) and Strauß (defense). To prevent space science from becoming another issue here, Balke looked for a name without explicit reference to "space." Bartels (and others) disliked Balke's solution because of its lack of "public appeal'' (Bartels to Gentner Oct 5 1960).

[22] In late 1959 the MPG had acquired an area of land in Garching, south of Heinz Maier-Leibnitz' nuclear research reactor (nicknamed Atomei (atomic egg)) for its planned plasma fusion lab, the later Institute for Plasma Physics. See: S. Boenke, *Entstehung und Entwicklung des Max-Planck-Instituts für Plasmaphysik, 1955-1971*, 155F.

[23] Proceedings of the Senate of the Max Planck Society, 35, p. 49. Gentner was especially interested in the nuclear reactions induced by hadronic cosmic ray particles in meteorites. Later he called this the "starting point for our participation in space research'' (Gentner to Bartels May 3, 1962, Archives of the Max Planck Society, Berlin-Dahlem).

[24] The distinction between "working group" (Arbeitsgruppe, i.e. the inter-institutional board consisting of Bartels, Biermann, Dieminger and Gentner) and "research group" (Forschungsgruppe, i.e. the team of scientists and technicians to be engaged in extraterrestrial research) is only made for the sake of clarity here. The early documents do not use a univocal term for the team of researchers before there actually existed one in late 1961.

[25] On Simpson and van Allen in the early days of US space science, see: A. Needell, "Preparing for the Space Age: University-Based Research, 1947-1957," *Historical Studies in the Physical and Biological Sciences* 18:1, 89-109 (1987).

[26] As a scientific member of a Max Planck Institute he was entitled to the privileges of an associate professor (Extraordinarius) of a German university: lifetime employment with full salary after retirement (Emeritierung).

[27] Heisenberg and Biermann to Lüst, July 17, 1959 (Werner Heisenberg Archives).

[28] Heisenberg and Biermann to Hahn, September 12, 1959 (Werner Heisenberg Archives).

[29] See e.g. J. Krige, *The Prehistory of ESRO, 1959/60, From the First Initiatives to the Formation of the COPERS*, (Noordwijk: ESA HSR-1, 1992: 8-9); P. Fischer, *The Origins of the Federal Republic of Germany's Space Policy 1959-1965 -- European and National Dimensions*, (Noordwijk: ESA HSR-12, 1994: 6ff) and references therein.

[30] R. Lüst, "My Start In Space," in: G. Haerendel, S. Grzedzielski, G. Cavallo, Battrick (eds.), *40 Years of COSPAR*, (Noordwijk: ESA, 1998:72).

[31] G. Gambke, R. Kerscher, W. Kertz, *Denkschrift zur Lage der Weltraum-forschung in der Bundesrepublik Deutschland*. For further details on this DFG study report, see: P. Fischer, *The Origins of the Federal Republic of Germany's Space Policy*, 11-13.

[32] Biermann, L. et al., "Zur Untersuchung des interplanetaren Mediums mit Hilfe künstlich eingebrachter Ionenwolken," *Zeitschrift für Astrophysik* 53, 226-236 (1961).

[33] For more information on earlier American and French rocket-borne experiments with sodium vapor clouds (conducted resp. in 1955 by Edwards, Bedinger and Manring and in 1959 by Blamont), see: J. Blamont, "The Beginnings of Space Experiments in Munich," in: G. Haerendel, B. Battrick (eds.), *Topics in Plasma-, Astro- & Space Physics -- a volume dedicated to Reimar Lüst*, (Garching: MPE, 1983: 161-164) (1983). For the British experiments (by Bates in 1958), see: H. Massey, M. Robins, *History of British Space Science*. Sodium is not photo-ionized by sunlight and therefore cannot trace magnetic fields. Instead, scientists were interested in temperature measurements in the otherwise inaccessible altitudes of 100-200 km.

[34] J. Blamont, "The Beginnings of Space Experiments in Munich," 162.

[35] This section is based on the correspondence of Heisenberg and Biermann with Meyer and Balke (Werner Heisenberg Archives) and of Lüst with Meyer (Archives of the Max Planck Society).

[36] A. Russo, *ESRO's First Scientific Satellite Programme* 1961-1966, (Noordwijk: ESA HSR-2, 1992: 16-18); P. Fischer, *The Origins of the Federal Republic of Germany's Space Policy 1959-1965*, 13-28.

[37] Ludwig Bölkow (born 1913), an aviation engineer, was a very successful enterpreneur in the sector of aviation, space and military technologies. His company (bearing his name) became the leading part of MBB (Messerschmitt-Bölkow-Blom) and was involved e.g. in the Airbus plane. Today MBB is part of DaimlerChrysler Aerospace.

[38] Biermann to Heisenberg Sep 13, 1961 p. 2 (Werner Heisenberg Archives).

[39] Biermann, memo titled "Vermerk über den Aufbau der Extrater-restrischen Forschung..'' dated May 19, 1962, and Lüst's opening address for the new Institute building February 15, 1965 (both at the Werner Heisenberg Archives).

[40] Technically, the team was under the Institute for Physics and Astrophysics, since Lüst stayed on the institute's payroll until 1963.

[41] Heisenberg and Biermann, memo titled "Aktenvermerk betr. die zukünftige Entwicklung der Abteilung Lüst im Institut für Astrophysik,'' dated Jan 16,1962 (Werner Heisenberg Archives).

[42] H. Ballreich, memo dated June 6, 1962 (Archives of the Max Planck Society).

[43] R. Lüst, "Internationale Zusammen-arbeit auf dem Gebiet der Weltraumforschung und die Beteiligung der Max-Planck-Gesell-schaft'' p. 11 (Werner Heisenberg Archives) (without date, but most likely this essay was Lüst's report to the authors of the DFG study report which was completed in September 1960).

[44] NASA required that the scientific payloads for satellites be first demonstrated with sounding rockets (Krige & Sebesta, 276). Strict environmental requirements and liability issues for launches from US territory also complicated things.

[45] Lüst's correspondences with the Ministry of Culture of the state of Lower Saxony (Archives of the Max Planck Society). Lüst eventually declined the Göttingen offer in July 1963.

[46] Heisenberg to Butenandt January 10, 1963 (Werner Heisenberg Archives).

[47] Butenandt, report to the senate of the MPG, March 1, 1963; Wagner to Bartels, Biermann, Dieminger, Gentner, Heisenberg, Köster, Mattauch and Schlüter, March 7, 1963 (Archives of the Max Planck Society)." Soon after he became director, Lüst also accepted the offer from Paris and became COPERS' scientific director on a part-time basis until the establishment of ESRO in May 1964.

[48] Proceedings of the senate session on March 13 1960, 44.

[49] Annual Report of the Max Planck Institute for Extraterrestrial Research, 1984, 21ff; G. Haerendel, "Curiosity and Chance, Pioneers in Space Physics" 2, *Journal of Geophysical Research* 101, 10541-53 (1996).

Overview of the Major Institutes of the Max Planck Society (MPG) Mentioned in the Article, Their Location and Directors During the Period Covered

INSTITUTE	SUB-INSTITUTE	LOCATION	DIRECTOR
MPIPA (Max Planck Institute for Physics and Astrophysics	Institute for Physics	Munich	Werner Heisenberg (also overall MPIPA director)
	Institute for Astrophysics (IAP)	Munich	Ludwig Biermann
	Institute for Extraterrestrial Physics (IEP)*	Garching (near Munich)	Reimar Lüst
MPAe (Max Planck Institute for Aeronomy)	Institute for Ionospheric Research	Lindau (near Göttingen)	Walter Dieminger (also overall MPAe director)
	Institute for Stratospheric Physics	Lindau (near Göttingen)	Julius Bartels
MPK (Max Planck Institute for Nuclear Physics)		Heidelberg	Wolfgang Gentner

*More commonly referred to as the Max Planck Institute for Extraterrestrial Physics or MPE, the abbreviation used in this article.