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Demarcations in the Void: Early Satellites and the Making of Outer Space

Daniel Brandau[*]

Abstract: *»Grenzziehungen in der Leere: Die ersten Satelliten und die Generierung eines Außenraums«.* During the early Cold War, outer space became a politically contested space, and changes in its spatial perception were related to political and ideological controversies. The article highlights the specific relevance of Euclidean geometry in representations of outer space. Focusing on illustrations and expositions in both postwar German States, it argues that shifts within the spatial imagination and representation of space corresponded with the first satellite missions and condensed debates about the future of technology and the moral legacies of the Second World War. In October 1957, Sputnik I, the first artificial satellite to orbit the Earth and a Soviet construction, urged engineers, scientists, and illustrators to find new ways of depicting and communicating the spaces of outer space to the public and to each other. For decades, space fiction had implicitly stifled theories on the relativity of space and time by hinting at traditional motifs of conquest through machines. Early spaceflight, however, was not about immediate flights to other planets, but about the orbit, a space without a traditional place, yet imagined as being of paramount importance for strategic superiority. Driven by political tensions and drawing on representations established in physics and astronomy, the first satellite projects were designed and explained as missions to places that needed to be defined and controlled because they were strange and new.

Keywords: Outer space, spaceflight, spatiality, sputnik, Cold War.

1. Space and Politics

Until the 1940s, outer space was practically out of reach. Modern rocket technologies, such as the German ballistic missile A-4/V-2 of the war and the intercontinental missiles of the 1950s, changed that: Their flight paths went beyond the atmosphere.[1] Since repulsion also works in empty space and the multi-stage

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rockets of the mid-1950s generated adequate velocity, outer space became a possible destination. Engineers had intensely debated this project since the interwar period and propagated the placement of an artificial satellite in an orbit around Earth as the first and foremost goal of a new age in science and technology (Brandau 2012b; Geppert 2008; Neufeld 1990). But it was neither European enthusiast groups nor the American military that first realized this project, announced as an official goal of the International Geophysical Year (1957-1958) by both Cold War superpowers USA and USSR. The latter were the first to follow through on their intent by utilizing and adapting their intercontinental ballistic missile R-7. The Soviet satellite 'Sputnik I' sent its eerie sounds to radio observatories around the world on 4 October 1957, indicating that it had reached a stable position in Earth orbit, traveling in circles over all countries of Earth. Images, however, were missing at first – it was sounds that suggested the dawn of the space age, and artists' illustrations slowly made up for the absence of photographic evidence that could not be delivered in the days of the first satellites.

A look at the changes in the discussion of the spatiality of outer space exposes a political dynamic. Section 2 of this article discusses the role that technological objects had in the imagination of the cosmos from the late nineteenth century. Section 3 examines the construction of spatiality as a collaborative project of engineers, scientists and illustrators in twentieth-century Europe, shaped by technological progress and scientific theory. Sections 4 and 5 explore the organization of this new space as a political process influenced by controversies over the very same technologies that had made it accessible, eventually setting the basis for the United Nations space treaties of the 1960s. The article gives an overview of the spatiality of outer space as a cultural problem and explores a specific case. In particular, the third and fourth sections focus on technology and spatiality as matters of contention between postwar socialist East and capitalist West Germany. Section 6 gives concluding remarks. The article shows that concepts of outer space challenged traditional practices of 'making space,' resulting in combinations of notions from astronomy and technology. However, these practices in turn also correlated with new political readings of the world due to ideological confrontations after the Second World War. Therefore, outer space had a considerable impact on how practices of creating and reading spaces were updated along with the transformation of power structures "from imperial times to the Cold War." Artificial satellites were indeed "objects producing spaces." However, they did not only create outer space while actually being in it, but also through models being displayed in museums. Relations between objects and spaces were complex and regularly drew on substitutes, visualizations and musealizations (Schillings and van Wickeren 2015, in this HSR Focus, 6-7, 10).

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Many influential studies on the history of cartography and mental representations of spaces and maps were published in the mid-1990s and early 2000s (e.g. Black 1997; Driver 2001). Of particular influence in history was Edward Soja's work that was based on French theory, especially Henri Lefebvre and Michel Foucault (Soja 1989). In the past decade, however, general methodological discussions in geographical history slowed and have mostly been carried forward with regard to specific issues. In particular, recent studies have convincingly problematized 'Western' perceptions of space (e.g. Osterhammel 2014; Schlögel 2011). Nevertheless, theories of spatiality were intensely debated in literature, art and theater studies, and they also found their way into discussions on the history of technology, mostly due to influences from Anglo-American science and technology studies (STS) and questions about technology-assisted knowledge production in laboratories (e.g. Damir-Geilsdorf 2005; Winter 2009).

Outer space has recently served as an odd and fascinating case for scholars concerned with theories of space, but mostly from an STS perspective. David Mindell and William J. Clancey have employed micro-perspectives to explore the social construction of space in networks of scientists and engineers, for example through space command centers and the application of virtual reality technologies to create and communicate knowledge about planetary spaces (Clancey 2012; Mindell 2011). At the same time, outer space was never only a concern of specialist projects. Techno-scientific practices were interrelated within larger cultural and political debates, particularly in spaceflight projects run by a diverse group of professionals, dependent upon massive state funding and often considered of paramount importance for either security or prestige by the governments that funded them.

During the twentieth century, the spatialization or, to be more precise, the redefinition of the spatial parameters of outer space shaped debates about the spatial extension of nation states not only through manned spaceflight, but also through orbital technologies, such as satellite reconnaissance, as well as weather forecasting and Earth-imaging satellites, such as in the NASA Landsat program. This article argues that in the early twentieth century, classical Euclidean geometry was retained and highlighted in illustrative concepts, whereas new theories actually questioned and relativized the integrity of classical notions of space. In the 1950s, this mostly visual strategy of communicating knowledge became politically attractive for promoting spaceflight and space security: Euclidean notions of bodies in outer space were not scientifically invalid, but merely restricted perspectives and scales. At the same time, they made the spaces around Earth appear accessible and appealed to a Cold War reading of the world as a constantly changing system of fixpoints instead of definite borders.

Visual technologies were essential in the inter-professional as well as in the public perception and communication of worlds beyond Earth: Just like in ocean cartography, as pointed out by Sabine Höhler, "specific modes of repre-

sentation enabled and limited what became perceptible and apparent" (Höhler 2002, 3). Since visual representations have always been fundamental to geometry, they were of particular importance to scientific research. In the modern period, Immanuel Kant's 'constructive intuitiveness' was often substituted with what Olga Fernández-Prat and Daniel Quesada have called the 'pictorial intuitiveness' of Euclidean geometry (Fernández-Prat and Quesada 1997, 118-20). In turn, the essential role of images is the epistemic reason and the first part of the explanation for why Euclidean geometry became essential in popular spatial thought of outer space despite the advent of non-Euclidean geometry and theories of relativity in the nineteenth and twentieth centuries.

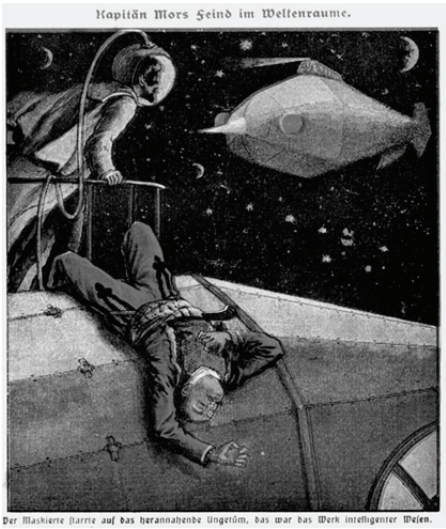
The first artificial satellites were 'things' that travelled through unknown spaces. These spaces had to be explained, but this production and popularization of new knowledge also shed a different light on the 'things' themselves. In particular, rockets lost their futuristic connotations because the more they became successful technologies, the more they were also feared as objects of ambivalent potential. Bruno Latour has described how technological things such as the airplane have 'blackboxed' the agencies of the many people involved in the construction and use of that technology into a "singular point in space and time" (Latour 1999, 183-5). Satellites and spaceships were indeed considered technologies to control and even colonize new worlds from a very small and changing position in space. From a wider cultural perspective, however, this strategy was far from straight-forward or successful, especially since outer space was an expanding realm: Spaces in outer space were constantly created, expanded, and debated. Relationships between technologies and space were complex since interpretations of controversial technologies such as rockets were increasingly used to develop a moral constituent. At the same time, new two- and three-dimensional representations of outer space based on Euclidean notions became ideal political tools to convey the spheres around Earth as strategic spaces. They claimed future-orientedness as well as ideological legitimacy and superiority for the side that was first able to employ these images as depictions of an actual technological achievement. At first this was, in principle, nothing more than the shot of a thing into a stable position in empty space.

2. Fictions: Technology and Conquest

For a long time outer space, as opposed to geographical space, was not a place of human action. Even from the 1960s onwards, few beings have actually been outside the Earth's atmosphere. Therefore, the spatiality of outer space and its consequences have at all times been delineated and debated mainly through representations. Henri Lefebvre has famously categorized representation as a practice complementing the social and the artistic production of space (Lefebvre 1991, 38-9). Depictions of the cosmos in models and illustrations

represented a world that could, in principle, also be accessed directly. However, this 'outer realm' could hardly be defined as a social space in the traditional sense. Satellites or space travelers were later able to define and describe spaces within spaceships or between objects in the Earth's orbit. However, it remained true that outer space was unlike any traditional geographical space: It offered no edges, borders, fixed landmarks, 'ups,' 'downs,' or even limits. Adding to the problem that technologies such as spaceships and suits were always needed to access and sustain life outside the atmosphere, it has been "virtually impossible to experience outer space in a direct, unmediated manner" (Geppert 2012, 13). Nevertheless, more than merely being an intellectual concept, many spaces were created within this endless emptiness, often technologically mediated and constantly changing in relation to social and political spaces on Earth.

Figure 1: The Cover of *Der Luftpirat* No. 38 (1908)[2]



Source: *Der Luftpirat* 38 (1908).

During the early modern period, physical models of the solar system condensed its spatial extensions but established relations between natural bodies, in particular the planets and the sun. Wooden models based on the findings of Nicolaus Copernicus (1473-1543) conveyed three-dimensional concepts of the solar

[2] This cover depicted human and machine in outer space, as well as the sight of intelligent extraterrestrials, signaled by a vehicle very similar to the human-made airship turned spaceship in the foreground. Strange new worlds were far from strange in the 1900s: Images in space fiction were dramatic and concentrated on men, machines and interaction. Even the conquest of new species of life was a rather familiar than unfamiliar prospect.

system. The imagination of spaceflight in the late nineteenth and twentieth century, however, was much more dominated by two-dimensional depictions of outer space. This reduction had to do with the advent of lithography that made cheap illustrations of mass-produced fiction possible. Technology magazines and dime novels established images of outer space that remained influential until the late 1950s. Novelists, such as Jules Verne or Kurd Lasswitz, were generally more optimistic, and astronomers rather skeptical about the idea of spaceflight, but both their perspectives and knowledge came together in fantastic voyages into the worlds above as seen, for example, in shows of the Berlin science theater 'Urania' (Brandau 2012a; Lasswitz 1897; Verne 1876). Technology was discussed as enabling mankind to reach places outside the Earth. Meanwhile, illustrations became important tools of demonstrating these new possibilities to popular audiences and introducing places worth going to, such as celestial bodies.

These images were two-dimensional but hinted at a third dimension that could be controlled by technology, thereby mediating tensions between depictions of progress and notions of conquest. In particular, these developments around 1900 corresponded with new trends of visually displaying human beings and technology interacting in a three-dimensional environment. Fiction and popular science accounts established two different perspectives: images of the spaceship, as in the dime novel series '*Der Luftpirat*' (1908-1912, see fig. 1), emulated the composition of photographs of dirigible airships (1908-1912). On the other hand, depictions of places on the Moon or planets, for example Wilhelm Kranz's drawings that were used in the 'Urania' show, often resembled romanticist landscape paintings (e.g. Meyer 1891). Things and spaces complemented each other in these imagined worlds. In that configuration outer space was suggested as a space of human action: Spacefarers were imagined as dependent upon technological extensions, and science fiction gave them things and beings to interact with, drawing on the long-established extraterrestrial life debate (see on the history of that debate: Crowe 1997; Dick 1982). Interaction, however, also implied that outer space was a world of potential conflict.

3. Sciences: Planetary Views

In the first half of the twentieth century, new theories on the interaction of matter with spacetime, in particular Albert Einstein's (1879-1955) special and general theories of relativity, profoundly influenced abstract concepts of the universe, but they were only of peripheral relevance in the imagination of spaceflight, in popular astronomy and in political discourse. These new theories were reactions to nineteenth-century discussions about a hypothetical 'ether' as a medium for the expansion of light waves, a concept that had contradicted Newtonian laws and seemed uncanny (*[g]espensterhaft*, in Einstein's words)

even to physicists (Einstein 2006, 97). While Einstein's ideas sparked controversies in interwar Germany, spaceflight enthusiasts rarely embraced his theories, but rather stressed the traditional role of technology in taming any 'uncanny' void. Meanwhile, astronomical illustrations highlighted Euclidean notions of space (Dieter Hoffmann 2007; Einstein 2002; Kleinert 1978, 1980). Euclidean metrics had been dominant especially before Descartes (1596-1650) and had introduced the spatial continuum. Still fundamental to most geometry despite the advent of non-Euclidean geometries in the nineteenth century, it constituted space as a basic relation between bodies (on the history of non-Euclidean geometry: Greenberg 1993; Rozenfeld 1988). Euclidean thought was flexible in its rationale of pinpointing positions without giving up the idea of the absolute altogether.

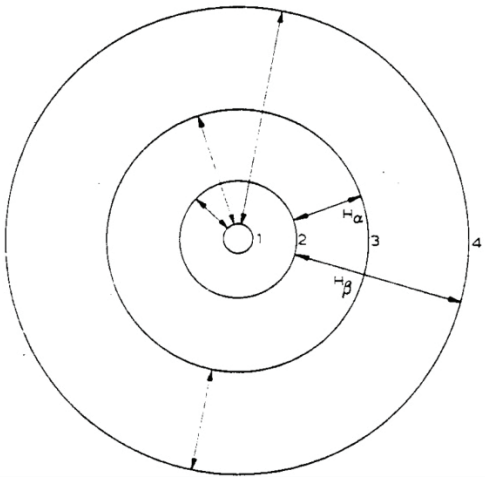
In the special theory of relativity, Euclidean metrics remained valid, but only when involving an 'imaginary time coordinate' as first introduced by Hermann Minkowski (1864-1909) as the fourth coordinate in a four-dimensional space-time continuum (Minkowski 1908/09). The spatial continuum became less reliable and calculable on its own. It might seem easy, from the viewpoint of a historian, to conclude a regress of space behind time or a compression of the spatial imagination (maybe even concurring with a general cultural acceleration) as modernization theories have suggested. The notion that time prevailed over space in late 20th century geopolitics has mostly been based on postmodernist theory (e.g. Der Derian 1990). From a media studies perspective, Marshall McLuhan has influentially argued that communication technologies were able to condense social spaces into a 'global village' (McLuhan 2003, 6). In From a cultural and political perspective, and particularly in regard to outer space, however, traditional spatial thought was rather reaffirmed through three-dimensional readings of environments. Space, which now had to be constructed as controllable in confrontation with its own relativization, became even more relevant as an intellectual resource. The popular retreat to Euclidean geometry can be read as the recurrence of space within concepts of time: Even in physics, time coordinates had to be expressed as quasi-spatial coordinates.

Classical geometry became essential for the discussion of outer space in the twentieth century – not only in popular representations, but also in the professional discussion of outer space and spaceflight projects between different disciplines, even when the theories of relativity were firmly established in respective fields. The planetary model, in its universal compatibility non-dependent upon fixed coordinate systems, became a key visual strategy in mapping the cosmos and tying it to notions of technological advance. Therefore, progress was visualized particularly through orthodox and contested methods and models of space.

In its similarity to models of orbital systems around planets or suns, new models of the atom suggested a consistency between the cosmos and microcosms – worlds that, in physics, had just been divided by different applications of the fundamental interactions of nature. In particular, the weak nuclear force only applies to subatomic particles. Similar models of atoms and orbits concep-

tually bridged a gap that deepened in the sciences. This connotation had been made explicit already in Hantaro Nagaoka's (1865-1950) 'Saturnian' and Niels Bohr's (1885-1962) quasi-planetary model of the atom in 1903 and 1913, respectively (see fig. 2) (Shaviv 2010, 89). The circular model allowed allusions to scientifically discarded concepts of space when it linked macroscopic to microscopic perspectives. In turn, this link was picked up in astronomical works and specialist debates about hypothetical flight paths to other celestial bodies, such as in Walter Hohmann's '*Die Erreichbarkeit der Himmelskörper*' of 1925 (Hohmann 1925). On the one hand, the cosmos was reduced within concepts of the orbit. On the other, this reduction even to a two-dimensional line implied a reading of the globe as a three-dimensional body through a change of perspective.

Figure 2: Schematic Depiction of Niels Bohr's Model of the Atom Used to Illustrate his Nobel Lecture in 1922[3]



Source: Bohr (1965, 17).

In astronomers' circles, these scientific reconfigurations of outer space already became important in the interwar years, but they gained popular and political relevance in the 1950s. Outer space was imagined as a futuristic world, but from the 1900s to the early 1950s, engineers were much more successful in conveying their visions of the future that highlighted technological progress and mostly ignored the problem of outer space being very different from Earth or air space. Visual images about spaceflight continued to accentuate human-made objects – especially, from the 1920s onwards, the rocket spacecraft. The Second World War prolonged this orientation towards technology in the popular imagi-

[3] © The Nobel Foundation, Niels Bohr 1922.

nation of outer space. There has been some controversy about the actual amount of influence of engineers in the 'Third Reich,' especially since the publication of Jeffrey Herf's 'Reactionary Modernism' (Herf 1984, 2010; Guse 2010; Rohkrämer 1999). The impact of an 'engineering mindset' in the late 1930s and 1940s popular culture was profound in either case, with countless publications on machines and works of technology fiction (e.g., the works of Hans Dominik and Wilfrid Bade: Bade 1937; Dominik 1939; Fischer 1984; Härtel 2004; Schwiglewski 1995). During the war, the popular belief in wonder weapons was fostered immensely, and the association of conquest and rocket technology also permeated depictions of spaceflight, such as the 1940 Nazi *Kulturfilm* '*Weltraumschiff 1 startet*' (Kutter 1940). The belief in superweapons was widespread in Western countries during the war, although particular strategies and technologies differed (see on the US: Franklin 2008).

This mode of thinking survived until the mid-1950s, when it was challenged from two directions: The practical militarization of outer space on the one hand, and the transnational movement against the deployment of nuclear missiles on the other. It was consequential that outer space was first reached and crossed by ballistic missiles during the Second World War, after the German 'Paris gun' of the first war had set the prior height record by touching the upper stratosphere. Weapons practically 'mapped' the void long before notions of outer space as a battleground were seriously discussed outside of fiction, and before the spatiality of outer space was acknowledged as something very unlike anything on Earth. As Paul Virilio has noted, actual developments of new technologies and weapons in particular concurred with the establishment of ideas of new spaces that need to be occupied, secured, defended and colonized. Natalie Bormann has argued that this particularly applied to outer space (Bormann 2009, 78-9; Virilio 2007). Once the practical relevance of these new machines was realized, notions of space had to be updated in political discourse, thereby facilitating also a shift in the influence of professions.

Scientists played an important role in the postwar international movement against nuclear missiles, at first through public appeals such as the Russell-Einstein manifesto of 1955. This was followed by several similar campaigns before and during the International Geophysical Year 1957/58. In Germany, prominent scientists such as Nobel Prize winners Max Born (1882-1970) and Otto Hahn (1879-1968) declared their refusal to participate in any nuclear weapons development projects. In the long run, prophesying the future and, in particular, the risks and dangers of technological development increased their political influence through networks such as the Pugwash conferences and, in the case of American scientists, in committees such as the US President's Science Advisory Committee – as an expert counterweight to the 'military-industrial complex' (Lewer 2013, 72-3; Wittner 1993, 55-79). These alternate future visions, which superseded engineers' ideas of linear progress, also corresponded with a spatial reinterpretation of outer space in popular depictions.

Euclidean geometry highlighted spatial parameters much more than the spaceflight techno-visions that were popular amongst engineers and the illustrators they collaborated with, such as Hans (1896-1970) and Botho von Römer (1896-1980). However, Euclidean notions did not devaluate, but rather emphasized Earth as a parameter and stressed 'global' perspectives. When the planet failed to be locatable in a system of coordinates, its surface remained an essential zero point in this accessible outer space, incrementally displayed in retrospective images when they could be reproduced in photographic form. Since the late 1960s, photos of Earth such as 'Earthrise' (1968) and 'Blue Marble' (1972) were regularly considered the most popular images released by NASA (Poole 2008, 156-8).

This Euclidean notion of a limited relativization of the spaces around Earth, with the planet being a reliable fixpoint, became dominant especially in 1950s illustrations of outer space for two reasons: First, on a professional level it complicated the engineers' vision of linear progress and outer space as quasi-territories amenable to conquest. Second, it was politically useful since it highlighted the relevance of the global ideological struggle on Earth. Established scientific knowledge was transformed into a political resource.

4. Politics: Threats and Control

When the successful start of the Soviet satellite Sputnik I was announced on 4 October 1957, this was more than just spectacular news. Recent publications have convincingly argued that there was no real 'Sputnik shock' in Europe, and even in the US it might have rather been a short-lived media phenomenon or a dynamic in federal 'expert' committees (Geppert 2009; McQuaid 2007). Nevertheless, Sputnik's long-term implications were profound and very visible also in the European press, albeit with conspicuous insecurity and rather small headlines in its first days and weeks (Geppert 2009, 76-81). The preceding section has argued that scientists had already been developing new concepts of outer space since the 1900s, but only became politically and popularly influential in the 1950s. Then, however, these newly established concepts of space were increasingly employed by various political actors for various political reasons.

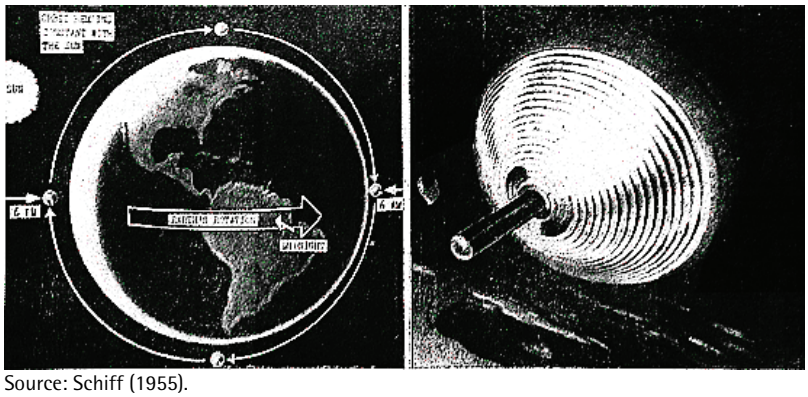
Scientific knowledge about the spatiality of outer space was occasionally utilized and illustrated in popular media as early as in the summer of 1955, as a reaction to US and Soviet satellite project announcements. The breakthrough of this strategy of communicating new knowledge, however, was in 1957, with the deployment of Sputnik I in Earth orbit. Newspapers in the East and the West faced the problem of having to explain the technological object as well as what it did and where it was, while information offered through the Soviet news agency TASS was rather limited. Sputnik sent signals that could be picked up by radio all over the world, but where exactly was their place of

origin? Sonic signals hinted at the spaces they originated in and were traveling through, but without visual contextualization they remained rather uncanny signals from spaces without pinpointing places. Traditional visualizations of rocket spaceships and planets were no longer sufficient to describe the spatial dimensions of the worlds outside the Earth's atmosphere. The complementation with sonic information was a stimulus for creating new depictions, but history and ideology were essential factors in how this change came about. During the Second World War, still in fresh and frightening memories, radio messages had been made meaningful by complementing them with maps (Casey 2008). 'Sputnik,' however, was a problem in that it was difficult to localize and represent its whereabouts. Illustrators created maps of the spaces 'Sputnik' was traveling in, but instead of landmarks, these maps relied on the human-made object itself to establish the orbit as a place in empty space. For immediate coverage, newspapers drew on their own science journalists who were often unfamiliar with the outer space topic, but could interpret political implications, and on rocket engineers and spaceflight enthusiasts as guest writers to provide technical explanations.

However, creating images for the space age became a problem that had to overcome its own traditions. The growing popular prevalence of the orbit in illustrations of spaceflight also had political reasons that were particularly notable in postwar Germany: Socialist East and capitalist West Germany were fighting each other over the claim of representing the legitimate 'new' Germany. As much as the rocket had been dominating German spaceflight thought at least since the 1920s, the V-2 had ruthlessly revealed the technology's ambiguity as part of a Nazi past that both States tried to dissociate themselves from. Illustrators had an essential role in ideological re-adjustments of images of future worlds. Their depiction of globes, spheres and circles instead of rockets, to put it simply, was one way of achieving that (see fig. 3).

The orbit, however, had to be visualized to be conveyed: Illustrators especially turned to the 'atomic model' and enhanced maps of Earth to accomplish that, thereby introducing new ways of representing the dimensions of the planet and the cosmos in the press. Orbits, shown as lines and curves, encircled a space that had become accessible. However, these lines represented flight paths and no borders: The infinity of this new space of human potential was emphasized by open margins: The orbit could be extended or connected with other potential orbits around other planets in maps of the solar system. Between 1957 and 1961, photographs were increasingly employed to illustrate the 'human factor' and complement orbital depictions. They had usually been released by Soviet and US news agencies: Institutions and governments gradually reclaimed their dominance in visualizing their successes in outer space. By focusing on either planet Earth or the acting subjects of spaceflight, animal and human cosmonauts or astronauts, these pictures emulated compositions established by illustrators in the late nineteenth century.

Figure 3: Depiction of an Orbit and a Satellite, 1955[4]



Source: Schiff (1955).

The spaceship remained an element of this pictorial canon after Sputnik I. However, rocket images were less and less used, although they were on a temporary upswing in the days of the American Apollo program. When they were shown, rockets could often be seen as disintegrating after the launch, setting free the actual ship or scientific payload. The official newspaper '*Neues Deutschland*' of the socialist SED party that ruled East Germany was influential in popularizing these and other visualizations just a few weeks after the flight of the first Sputnik in a special issue (1957b).

Another reason for the growing differentiation of spaceflight and rocketflight was professionalization in enthusiast circles: Talking seriously about spaceflight meant distinguishing it from the fantastic space operas that were popularly known. However, that development was not limited to proponents of rocket and spaceflight programs who tried to secure funding from public bodies: Science fiction itself increasingly strove to appeal to adult audiences. In the mid-1960s, adult science fiction such as the German '*Raumpatrouille Orion*' or the American 'Star Trek' often distinguished itself from the prewar US movie serials for children 'Buck Rodgers' and 'Flash Gordon' by using designs based on flying saucers instead of rockets (Cushman 2013, 132).

But why was the rocket 'old-fashioned' at the very same time when rockets actually carried machines and people into outer space? In the end, the reasons

[4] As a counterpart to the ever-present A-4/V-2 pictures in the press, already around 1950, image combinations of the orbit and the non-rocket shaped satellite had been established in specialist journals such as the German *Weltraumfahrt*, a publication of the enthusiast society *Gesellschaft für Weltraumforschung*. After the official satellite announcements in both the USSR and the US, and amidst a growing nuclear rocket scare, these visuals were also used by the US daily press to explain the US satellite project 'Mouse,' here for example the New York Post on July 31, 1955. After Sputnik I, they were employed regularly and widely to now depict actual breakthroughs in spaceflight.

for that development were profoundly political: In the days of the first satellites, the rocket had been seen first and foremost as a major international threat, feared for carrying nuclear warheads, and heavily debated within and between East and West European countries. It seemed out of place in hopeful imaginations of the future. In 1957 and 1958, the peace movements took up the nuclear scientists' initiative and made the fight against missile bases in Europe one of their main goals, with support from churches and social democratic parties (see on the peace movements: Nehring 2005; Schildt 2009). Even when nothing seemed as futuristic as satellites and spaceflight: The rocket was not futuristic anymore.

The cosmos, on the other hand, was more and more idealized as a strange expanse, a space in which the (military) technologies of the present were no longer supposed to hold value. It was reimagined as a different and innocent realm, actively preserved even as the distant and harmonious utopia that nineteenth-century conservative astronomers had seen in it before engineers gained public authority over the popular depiction of outer space from around 1900 (Brandau 2012a). This alternative interpretation of the cosmos as a mystical world that man was about to destroy had survived in the cultural conservatism of the interwar years, and its return in the 1950s signaled a shift of public authority from engineers back to academies.[5]

New orbital representations carefully delineated spaces that were accessible from the worlds of astronomy, realms of engineering from those of scientific enquiry, the controllable from the uncontrolled. They confronted two very different concepts of outer space, a different political vision associated with each. The only 'things' in low earth orbit were technologies brought from Earth, while the strange worlds and objects in outer space seemed very remote. Therefore, the concept of empty orbital space highlighted human achievement, with new moral codes rather adding to than reducing its relevance. The Moon and the planets of the solar system, however, became important links between the two concepts of outer space. There were no borders, and the spheres of human control were as expandable as outer space became accessible. The reality of the extensive military use of outer space for reconnaissance and navigation was reflected and extended in science fiction, but it was marginalized in political long-term visions of peaceful and international spaceflight. This development also influenced the United Nations resolutions between 1960 to 1963 and the Outer Space Treaty of 1967 that emphasized exploration over weaponization or national occupation and forbade the placement of weapons of mass destruction outside the atmosphere (Haanappel 2003, 7-13; Lyall and Larsen 2009, 55-80; Wolter 2006).

Ideologically, the return to utopian notions of outer space had more to do with temporal than spatial reconfigurations. Concepts of time were used as a political resource when similarities between the East and the West in other

[5] Werner Deubel was particularly vocal in the interwar cultural conservative discussion about outer space (1944; Brandau 2012b; Deubel 1928).

areas such as spatial strategy and technology were inept for the display of ideological and moral superiority. However, despite rhetorical calls for long-term peace, the understatement of the role of rocket technology and the demise of notions of conquest in those illustrations of spaceflight that were gradually substituted with photographs, new illustrations of satellite orbits also implied contemporary military superiority: Mapping outer space demonstrated a Cold War strategic dominance superseding the rather imperialist technology images of the 1920s to 1950s.

The debate over the ambivalence of rocket technology became very distinct in the two postwar German states where it also constituted a controversy over ideology and wartime guilt. The East German government was particularly anxious to show that capitalist West Germany carried on moral legacies of the Nazi past by employing the very same engineers who had developed the V-2. The fact that Wernher von Braun and many of his team now developed rockets for the US Army was used as evidence of a shared Western responsibility for still remaining on the 'wrong side of history.' Fueled by West German rearmament plans, notions of the past and the future were intertwined in this controversy, especially in between 1955 to 1958. The philosopher Georg Klaus had established this interpretation of the 'fascist rocket' in an article in 1955. By the early 1960s, Wernher von Braun had become an important East German propaganda target (Klaus 1955; Neufeld 2012).

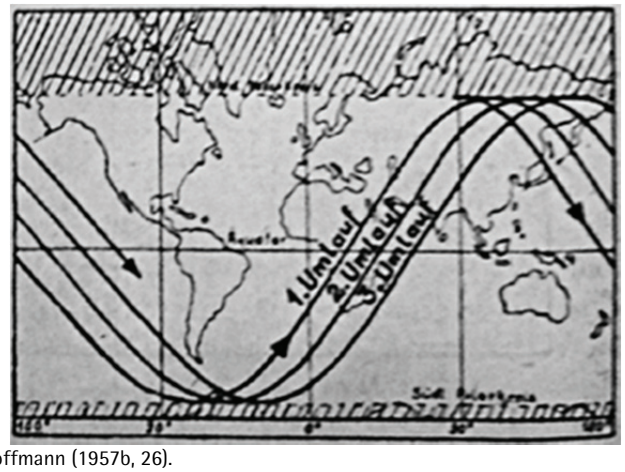
Therefore, when East German newspapers delivered illustrations of Sputnik I to German readers, these images were adapted to implicit comments on ideological differences. Already in 1955, SED Central Committee secretary Kurt Hager urged youth leaders of the *Freie Deutsche Jugend* (FDJ) to engage more in discussions about technology and spaceflight in particular and thus demonstrate to young people that "the future is here and the past is in the West, and that their past has been ill-fated and will be ill-fated again" (Hager 1955, 14; translations are my own). This was part of an attempt to decrease '*Republikflucht*,' emigration from the GDR, and to raise the attractiveness of engineering careers in preparation for the second five-year plan (see also: Radkau 2008, 394-5). FDJ-owned publishers were the first to react with books both on nuclear physics and space travel, the two major 1950s visions of progress concerning science and technology, respectively. Having titled his speech "We want to understand the world, explore outer space, and get to the bottom of things," Hager explicitly referred to both.

In this vein, images played a decisive role in being a method of linking the atomic age and the space age. East German illustrators such as Eberhard Binder-Staßfurt (1924-1998; '*Unsere Welt von morgen*,' 1959), Heinz Bormann ('*Kosmonauten-Fibel*,' 1961) and Erwin Wagner ('*Der Mensch im All*,' 1961) had the task of finding new ways of depicting outer space while keeping problematic rocket pictures to a minimum (Böhm and Dörge 1959; Hoffmann 1961a, b). Both nuclear physics and spaceflight were considered positively

groundbreaking and eminently useful for all mankind in the long run despite their problematic current applications. At the same time, this conflation of concepts also implied military power: Mapping both cosmic and microcosmic realms of future activity portended the capability to control those new spaces. The atom model hinted at nuclear energy and armament. The orbit, on the other hand, suggested control over the whole planet, apparent in an illustration of the orbit of Sputnik I that showed a red net around the Earth (Geppert 2009, 86-7). Often shown in fearful depictions in the Western press, a variation focused on a world-map rather than a globe (see fig. 4).

In a tradition of strategic thinking, the orbit suggested a narrative of gaining control over places in a two-dimensional, 'mapped' organization of the world. Technology was still imagined as the link between (three-dimensional) action in space and (two-dimensional) strategy, but ideology seemed key to superiority and legitimacy. The machine itself was either absent from these images or inscribed into an almost 'natural' system of spheres and curves. However, technologies were more explicitly depicted and used for propaganda purposes in exhibitions – a medium in which technologies could actually be presented as material 'things.'

Figure 4: Depiction of an Orbit on a World Map[6]



Source: Hoffmann (1957b, 26).

[6] The orbit on a world map showing the flight path of Sputnik 1 in the GDR newspaper *Neues Deutschland*. The flight paths of satellites and spaceships not only crossed borders, but did so in an absolutely indiscriminate and regular manner. They were shown not only as the triumph of exact science and technologies over 'old' nationalisms, but that triumph also appeared as a new kind of ideological conquest in itself.

5. Exhibitions: Dissected Machines and Accessible Spaces

Both in practice and method, exhibitions were pivotal in popularizing the spatial imagination of outer space during the early Cold War. Visualizations were effective, but not sufficient due to their dimensional limitations. Films had been used before to tie notions of space and time to action, but they had been works of technology fiction. Physical models, however, proved ideal to complement two-dimensional images and make this strange outer space not only visible, but able to be experienced as a controlled spatial world and a realm of human action. Initially more common in the West than the East, spaceflight exhibitions had been touring through West Germany and Europe since the early 1950s. On display were illustrations as well as models of rockets and spacecraft, and they had a more local focus, but usually a wider appeal than books. The makers of the exhibitions, often enthusiasts organized in rocket and spaceflight societies, were careful in dissecting and explaining the much-feared rockets. Again, however, Sputnik complicated these strategies. The Soviet government sent replicas of the artificial satellite to Western exhibitions and not only exposed the inferiority of Western technology. The exhibited objects unsettled all those carefully composed suggestions of control over outer space, depicting the latter as an arena of global political contention.

Modes of consumption of knowledge differed considerably from literature and magazine illustrations: Visitors arrived at a certain location and physically moved through stand-up displays. Experts were usually on hand for explanations. This set-up followed the decades-old practice of the spaceflight lecture in which an authority of the field would explain future technology with the aid of a model, a very popular image motif also in newspaper articles.[7] Heinz Gartmann, arguably the most influential German author on rockets and spaceflight before Sputnik, told his German-American colleague Willy Ley in 1954 that he thought that photos of experts and models were "cliché," but they worked every time and so he regularly used them: The combination of authority and technology was powerful in that it was dynamic even in still images, it implied "*Handlung*" (action), as Gartmann noted (Gartmann 1954a, b).

In 1952, the South German enthusiast society *Gesellschaft für Weltraumforschung* (GfW) organized a small exhibition in the *Landesgewerbemuseum Stuttgart* on the occasion of a congress of the International Astronautical Federation (IAF) that took place at the same time. The show complemented two types of American shows of the late 1940s, the Robert Goddard exhibits of

[7] The science lecture and the spaceflight lecture in particular had a long tradition in Germany since the 1890s, when Hermann Ganswindt presented spaceship ideas in Berlin. In the mid-1920s, rocket pioneers Max Valier and Hermann Oberth undertook lecture tours throughout Weimar Germany. See: Brandau (2012a, b); Neufeld (1990).

1948 and 1950 in New York and Washington D.C., after the late American rocket pioneer (1882-1945), and the rather science-fiction-oriented 'Conquest of Space' in Sacramento in 1951, based on Willy Ley's work of the same name (1957b; Guggenheim and Doolittle 1948). The latter was well-funded by companies such as Boeing and Lockheed, but it focused on entertainment and movie serials such as 'Flash Gordon' (1951a, b). Wernher von Braun and Walt Disney (1901-1966) also became influential in popularizing spaceflight, but the partnership's biggest outcome in terms of exhibitions, again supported by corporate sponsors, was 'Tomorrowland,' a Disneyland theme world in 1955 (Lucanio and Coville 2002, 140-68; Disney 1955). Adult exhibitions were in decline in the US by the mid-1950s.

At the same time, European exhibitions were much more political and aimed at showing that both rockets and science fiction were plausibly connected and that Europe was the ideal place where the spaceflight future could be initiated first. European enthusiasts were propagating internationalism and spaceflight as an ideal and peaceful joint project for the war-struck continent, and the Stuttgart show highlighted this aspect of future cooperation. A European political vision, outer space was presented as the spatial medium that connected science and fiction. Eugen Sänger (1905-1964), once designing rocket engines for the Nazi German Ministry of Aviation, now chairman of the GfW and founding president of the IAF, regularly explained spaceflight as the first activity in "a space that did not know national borders" and that created new problems that were only solvable through international cooperation. The "feeling of a common bond between all human beings when faced with the strangeness and menace of an outer world gradually coming closer" was "growing in an unforeseen manner" (Sänger 1956). Sänger was no 'UFO believer,' but he was well aware that in the age of the inescapable nuclear threat, the cosmos was no longer just a space to be conquered, but also the world from where major threats could descend upon mankind and Europe in particular (Sänger 1956, 27).

The Stuttgart exhibition, organized by popular science writer Alfred Fritz, became a great success: Within the first week, 5,603 visitors had seen the displays of flight path drawings and mostly self-built models, the impressive highlight being parts of an A-4 rocket that Alfred Fritz had received from Wernher von Braun (Koelle 1952). Regularly updated, the collection travelled to several German and European cities such as Turin in 1955. Also, models and material were increasingly exchanged and loaned across Europe (see on V-2 artifacts in museums: DeVorkin and Neufeld 2011; Fritz 1955).

The US Embassy in Bonn asked Alfred Fritz to help with an exposition for the American section at the Berlin Industries Fair in early October 1956, titled 'Space Unlimited' or '*Der unbegrenzte Raum*' (Fritz 1956). It became a huge success, drawing more than ten thousand visitors every day. Therefore, the exhibition was extended and also travelled to Munich afterwards (1956a; Büdeler 1956a, b). For the first time, a Soviet delegation spontaneously visited

the fair, a visit which was unwelcome not only by the press, but the West Berlin government as well. The Senate booked low-standard accommodation at Zoo Station for Minister for Metallurgy Sokolov and his entourage. The Hamburg newspaper '*Die Zeit*' commented that Berliners "from the West and East" – the border was still open – were impressed especially by the American satellite model and plans to shoot that aluminum sphere to a place 480 kilometers above Earth, but also noted a certain 'unease,' or "*Unbehagen*" (1956c). However, they also boasted that the Soviet delegation better take to heart this impressive display of what kinds of new worlds the West would be able to reach with peaceful cooperation (1956c).

Figure 5: Spaceflight Exhibition of the *Gesellschaft für Weltraumforschung*, 1952[8]

Source: *Gesellschaft für Weltraumforschung* (1952).

Organized by rocket enthusiast clubs, spaceflight exhibitions in Europe often received limited support from the industry and local public institutions due to security reasons and military secrecy. That changed during the International Geophysical Year 1957/58, when governments became more interested in using exhibitions for promoting peaceful applications of their rocket developments and turning dreaded technologies into prestige assets. Carefully crafted spatial representations of outer space continued to be a means of condensing and propagating the notion of West European and transatlantic cooperation in

[8] The 1952 spaceflight exhibition of the *Gesellschaft für Weltraumforschung* in Stuttgart focused on technology and showed models as well as rocket parts. Stand-up displays behind the models had two-dimensional drawings of outer space, diagrams, and flight paths. Image courtesy of the Department of Special Collections and University Archives, Stanford University Libraries.

technology and industry, enabling visitors to individually 'conquer' outer space and experience it as a future world shaped by collaborative technology projects. They wandered through an array of model spacecraft that was itself, in a self-referential spatialization of future visions, touring through Europe. The future was supposed to be in outer space, but where did this space begin?

Highlighting the role of human life and downplaying the relevance of ambivalent technologies and ideologies, enthusiasts had discussed the threshold to places outside Earth as a medical problem: Machines were tools for getting to and being where life was normally absent. Already in 1951, German-American pioneers in space medicine Heinz (1913-1990) and Fritz Haber (1912-1998), Hubertus Strughold (1898-1986), and Konrad Büttner (1903-1970) stressed that "space as a topographical concept is misleading when used in discussions related to manned rocket flight. Rather, these problems must be treated on the basis of the functions which the atmosphere has for man and craft." They proposed a focus on problems such as breathing as "a new concept of space which is more adequate to the peculiarities of manned rocket flight than is a topographical interpretation of space." (Strughold et al. 1951, 342) Medical aspects addressed the 'human factor' of space missions and reframed ambivalent technology to a bare instrument. However, as much as it was complicated to talk about pride in military technologies during the early Cold War, civilian applications were able to invert this new sensitivity. At least for a short moment of re-enchantment, hope in a 'true modernity' through technology seemed possible. Therefore, exactly at a time when the days of the linear technological progress narrative seemed to be coming to an end in both the East and West, the spectacular success of Sputnik I once again turned things on its head.

It was nothing short of a humiliation when the Soviet government sent models and replicas of their satellites to Western exhibitions in 1958, in particular the Brussels world fair, where models of Sputnik I and a planned Soviet moon ship stole the show. One year later, a replica of Sputnik III was shown at the Soviet National Exhibition in New York. As Lewis Siegelbaum has noted, Sputnik triggered a shift in Soviet cultural propaganda strategies, as demanded for example by space and technology enthusiast Vasilii Dmitrievich Zakharchenko (1915-1999), chief editor of the popular science magazine '*Tekhnika – molodezhi*': The "hymn to the new Soviet man/person" was recombined with what had often been neglected in post-Stalin times: "the 'depersonalized fruits of labor – machines, mechanisms, construction sites'" (Siegelbaum 2012, 126-7).

Indeed, it can be argued that the success of Sputnik allowed for the reintroduction of ideology into the discussion of technology. Technological progress in the postwar period had often been similar in the East and West, especially in rocket technology – due to the transfer of German engineers to both the United States and the Soviet Union. This had been accepted as pragmatism, but it was hardly an ideological triumph (e.g. Schliffke 1957). Sputnik, however, clearly deviated from old rocket designs, which made it ideal for propaganda purposes.

It was an outcome of Soviet science and seemed truly futuristic since it visibly moved on from World War technologies.

With Sputnik I, sounds had again preceded models and experiences of materiality, after radio observatories had regularly invited the public to listen to the satellite's sounds from outer space (1957a). More spectacular than illustrations, the models were representations of what was travelling around the planet and emanating those sounds. While the USSR section at the Brussels world fair outshone what the Americans had to offer, the architecturally impressive Belgian 'Atomium' turned out particularly controversial when in the summer of 1958 popular opposition against nuclear armament grew vocal and visible across Europe (see: Schauermann 2009, 216-8).

In the late 1950s, the microcosms of atoms and nuclear forces seemed even uncannier than the new worlds of outer space that Soviet engineers had just stepped into, and associations of both entailed controversial and challenging political tasks. Illustrations were heavily used for propaganda purposes in the GDR. Models, however, proved particularly useful on an international stage: Sputnik conquered outer space by literally advancing into exposition spaces in Western Europe, en passant disenchanting the A-4/V-2 rockets, which had so far been ambivalent but still futuristic highlights in Western shows and museums, to being nothing more than things from the Nazi past. Outer space was opened up, but the orbit delineated as a world of ideological contention.

6. Conclusion: Euclidean Spaces in a Cold War World

Three phases of popular spatial interpretations of outer space can be discerned: In the nineteenth century, astronomers had discussed and presented the cosmos as a strange and higher world. They acknowledged the possibility of alien life, but as a more intellectual than actual future problem. From around 1900, engineers and novelists began to highlight the potentials of technology with regard to the human conquest of new spaces outside the atmosphere. They often envisioned outer space as similar to airspace, as the potential carrier of just even more elaborate flying machines. At the same time, scientists developed visual concepts of orbital spaces, but were less influential in spaceflight debates. In the third phase, from preparations for the International Geophysical Year until after the flight of Sputnik I of October 1957, the spatiality of outer space was re-interpreted to complement both views: The first artificial satellites actually created spaces in outer space, and space probes started expanding the realms of human action. At the same time, the cosmos seemed remote again, despite being theoretically accessible. Two very different spaces were associated with different political visions: The orbit became a sphere of engineering and man-made things, national or private interests, security, acceleration, and utility. The cosmos was re-emphasized as a world of scientific curiosity, shared human interests and

timelessness, but also a cluster of real places from where the unknown could descend. Facing this new dynamic, planet Earth began to appear vulnerable.

The early Cold War was very different from the times of the two World Wars in that the engineers' dominance over the interpretation of space and the focus on machines were profoundly challenged. Technology became a much more ambivalent signifier of progress. Images were complemented with political calls for peaceful and international endeavor. Engineers and spaceflight enthusiasts discussed peaceful goals as a postwar vision, but by the mid-1950s their authority seemed less and less trustworthy. Political activists opposed ambivalent technology projects or called for non-technocratic control over them. Concepts and illustrations of the orbit had long been used, but it took reports about actual space technologies for them to take hold in popular and political discourse. Euclidean notions of space as defined by relations of bodies and objects did not contradict new scientific theories, but merely reduced perspectives to the realms that seemed relevant while moving on from imperialist images of territorial conquest. Orbits stressed the potential and need for control instead of conquest, but attached an ideological impetus to moving objects and technologies rather than space itself. This re-interpretation of spatiality was facilitated by struggles over authority and public knowledge, but the first artificial satellites were events with general epistemic as well as political implications for various actors.

New images suggested outer space to be of strategic value. This was no contradiction to peaceful utopia, but a mutual extension that implemented the concept of outer space into the Cold War context, suggesting military superiority as a present potential and international peace and cooperation as the long-term prospects that each ideology claimed to be the future provider of. The new spatiality of outer space was not entirely different from what had been before, but it was neither just the remote, time-less, superior, and almost mythical world of nineteenth-century astronomy, nor the seemingly well-known spaces of rocket fantasies and technology fiction of the first half of the twentieth century. It was both, ascribed to different worlds, often delineated by use of thin lines in two-dimensional illustrations. Science fiction integrated both concepts and showed human crews exploring outer space through technology, but also acknowledged the strangeness of the new worlds that often could not or need not be conquered anymore.

The spatiality of the cosmos was re-aligned time and again, always drawing on the images and concepts that scientists and engineers offered. The 1950s (re-)construction of remote outer space as a strange spatial world, whose conquest could neither easily be planned on a blackboard nor realized through the extension of military technologies, was driven by political and ideological contention. This Cold War phenomenon of deliberate ideological demarcation in science and technology can be traced in national and even local disputes and set the stage for representations and utilizations of (space) technology.

This entanglement of public knowledge about the cosmos and international political processes became evident when the first human-made objects entered a void that had been pictured as the place of humanity's future already for two preceding generations. Technology remained a motor of change into a potentially better future, but it was defined in terms of morality and guilt, which served to distinguish systems and ideologies. In the times of the nuclear threat, progress no longer seemed natural or linear, but political regimes were perceived as essential gatekeepers to either utopia or the apocalypse. Outer space, through its spatial construction and interpretation, became a medium for this deliberate political distinction.

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