"Science and Metaphor: A Truly Interdisciplinary Perspective. The Third International *metaphorik.de* Workshop"

(Olaf Jäkel, Martin Döring, Anke Beger)

There is no science without fancy
and no art without facts.

(Vladimir Nabokov)

Metaphor is an important epistemological ingredient in doing science. Science, technology, engineering, computing, mathematics and medicine heuristically use metaphors and discursively employ imagery to formulate hypotheses, to interpret scientific results, to propose new avenues for research and to communicate them to a wider public. Metaphors provide scientists with ways to interpret, present and manipulate data within particular scientific disciplines, in interdisciplinary as well as in extra-scientific contexts. They allow scientists and non-scientists to – sometimes cooperatively – explore highly abstract domains of knowledge and to contextualise and negotiate complex information. In brief, metaphorical reasoning is a basic ingredient in doing science because the conceptual power of metaphors provides scientists with efficient and productive ways to interpret and explore natural phenomena and processes.

The aspect of a metaphorically motivated scientific reasoning has attracted increasing attention over the last two decades, even though most research has been undertaken in the area of public understanding of science, while systematic, contextualised and applied research on metaphor in science is still lacking. Disciplines such as the sociology of scientific knowledge, science and technology studies, or the philosophy of science have acknowledged the importance of analysing the constitutive role of metaphor in science, yet without achieving to establish consistent theories and approaches. Why has metaphor not been investigated systematically in scientific contexts? Why has it not attracted more attention even if it is conceived as an essential ingredient in scientific reasoning? Part of the answer is that the role of metaphors has been minimised or side-lined in theoretical approaches in the aforementioned disciplines. Following the research agendas of science and

technology studies or the philosophy of science, the study of metaphor has been framed as not critical – at best – or as concerning words only – at worst. These deeply rooted prejudices towards the study of metaphor ironically refer to the traditional concept of metaphor as a rhetorical and stylistic device which has been challenged since the 1980s by research in cognitive linguistics, the discursive study of metaphor and a constructivist branch of the philosophy of science. The intent of this special volume of our journal consists in helping to bridge this theoretical and methodological gap by bringing together a series of international and interdisciplinary contributions that empirically investigate the creative and heuristic role of metaphor in science.

The Third International *metaphorik.de* Workshop took place from October 18 to 19, 2013, at the Institute for Language, Literature and Media Studies of Flensburg University, North Germany. With more colleagues attending and sharing in the discussions, eight researchers from three countries presented their contributions. Right from the start, we conceived of this workshop as an attempt to bring together scholars from the humanities, social sciences and natural sciences to explore the challenges to science and society posed by the proliferation and growing sophistication of the use(s) of metaphors in scientific contexts. Such an endeavour, we hoped, held the possibility to create a framework for researchers to harmonise scientific activities and promote theoretical and methodological synergies on a European level, to strengthen ongoing activities in the area of science and metaphor across Europe as well as to evaluate the current state of the art of research on metaphor and science.

The workshop aimed at answering some of the following questions: What is the heuristic and epistemological function of metaphor in science? What metaphors are used in different scientific domains? Are there common metaphors, or rather discrete metaphorical networks which are typical of scientific disciplines? How can metaphors or metaphorical models be connected to so-called paradigms? Do paradigm shifts rely on shifting metaphors and metaphorical models? What kinds of methodological approaches are needed to better understand and analyse scientific metaphors? Does the use of metaphor change when scientific results move out of the

laboratory and into the public? And what consequences does this have for public understanding? How can scientific and public trust be ensured when using metaphors to disseminate knowledge of scientific advances, engage the lay public with science or convey meaning in didactic contexts? What is the role of the scientists' world when the metaphorically suffused domains of knowledge are taken out of the hands of experts and become democratised? What is the role of metaphors in scientific publishing? What are the ethical and moral dimensions of metaphorical reasoning in the sciences?

It was Mary Hesse (1966) who pointed out what is probably the most important function of metaphor in scientific theorizing – the *explanatory* function of metaphor in scientific models. While studying the explanatory power of analogies or metaphorical models, Mary Hesse was primarily concerned with scientific progress, or "theories in the process of growth" (1966: 10). Thus, the explanatory value of some untried and therefore still neutral analogy lay in its *heuristic* function (cf. Jäkel 2003: 35-36). A prototypical example is described by another prominent philosopher of science: In *The Structure of Scientific Revolutions* (1962), Thomas S. Kuhn relates how the now conventional but then still new conceptualization of electricity as a *fluid* led some Dutch electricians to the creative extension that this fluid could perhaps also be *bottled* in some *container*: The result was the invention of the Leyden jar, the theoretical account of which by Benjamin Franklin led to the first full-fledged paradigm for electricity (Kuhn 1962: 17; 61-62).

Without doubt, the heuristic function of successful models like this is quite impressive. We believe, however, that Mary Hesse's approach can also be extended to another application of the explanatory power of analogies or metaphorical models in science, and that is in the shape of their *didactic* function. The view that metaphor and analogy are not only key features of theorizing amongst scientists, but are also important tools in teaching scientific ideas and models to a lay audience of students, has been pointed out by various researchers. To name but a few, Mayer (1993: 572) emphasizes that analogies foster learning processes and Justi & Gilbert (2006) argue that analogies are powerful tools for understanding new domains. In both scientific discovery and teaching science contexts, the role of metaphor is assumed to have

something of central importance in common: the function of bringing about cognitive change during explanations of scientific phenomena.

Let us exemplify this with an authentic piece of discourse (cf. Beger & Jäkel 2015) from a German school context (translated into English): The physics teacher in eighth grade, in the process of explaining refraction, tells her class: "Imagine the beam of light as *a car*." (Longer pause, in which she draws on the blackboard something like figure 1, but without the second arrow) "It moves from an even road onto a boggy field." (Pause, in which she points at her sketch) "And now ask yourselves: What is going to happen to the wheels?" (Longer Pause, until she adds the second arrow to the sketch)

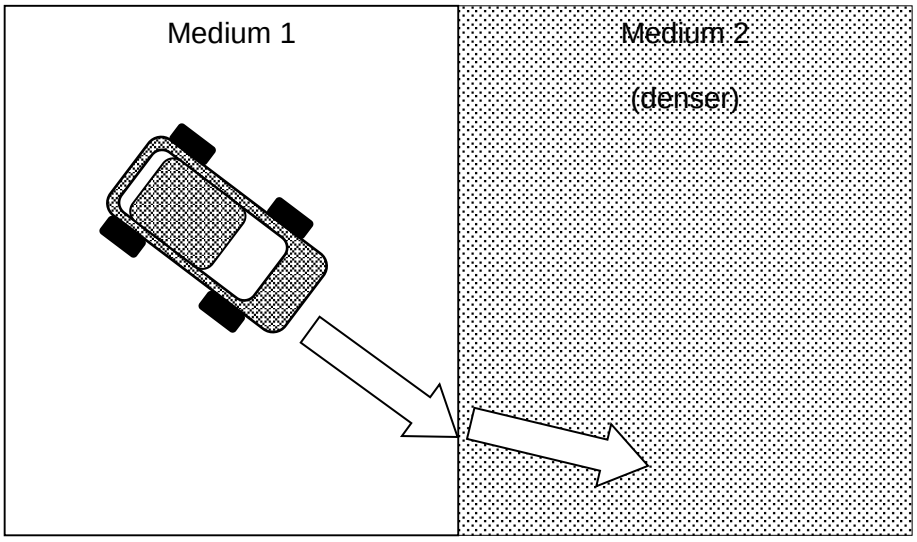

Figure 1: The car model of the light beam

During the teacher's pausing, many if not most pupils will have come to the insight that the car will be making a slight turn to its left, as the left front wheel will meet the denser medium a moment before the right wheel, and therefore be slowed down a bit. This insight, provoked by the very concrete and familiar car model, may even contradict intuitive judgments uttered before by the pupils as to how a light beam would behave when changing from one medium (e.g., air) into a denser medium (e.g., water), which tend to be erroneous. The insight based on the car analogy, though, is exactly what the teacher was aiming to induce in her pupils; and she

achieved this by way of her "metaphoric redescription of the domain of the explanandum" (Hesse 1966: 157).

While the theoretical take on metaphor loosely adopted in Hesse's (1966) work was the *Interaction View* on metaphor proposed by Black (1954), metaphor theory since has been massively affected by the cognitive turn in linguistics and the humanities, with the development of the *Cognitive Metaphor Theory* in the wake of Lakoff and Johnson (1980). Although these two views on metaphor differ in some respects, they both share the assumption that there is a metaphorical transfer from a more familiar domain to a domain we know less about. Since this seems to be the most important characteristic of metaphor in Hesse's approach as well as in a cognitive linguistic analysis of science teaching contexts, we will not further elaborate on the differences of these two distinct theories of metaphor here (for a comprehensive discussion see Jäkel 2003: 93-100). Instead, we will here put on record the shared insight that it is indeed the explanatory function of metaphor that is crucial – not only for scientific reasoning amongst scientists, but also in teaching contexts.

The contributions in this volume start with **Benjamin Specht**, philologist and scholar of German literature. His essay „Problemgeschichte in Metaphern. Am Beispiel der Elektrizitätslehre um 1800" outlines how in the late 18th century, scientific concepts of electricity make the metaphorical leap from physics to physiology and psychology, and even into the general vocabulary used to communicate new notions of feelings, especially regarding artistic inspiration and love. This historical example showcases the general capacity of metaphors in terms of epoch-specific 'problems': they can adapt the vocabulary to new 'problematic' constellations, imply ways to 'resolve' them, participate in building new models, contextualize and moderate problems, but also escalate and reinforce them. Due to these qualities possessed of metaphors, but often exclusively awarded to literary texts, the 'metaphorological' approach may methodologically deepen and complement literary studies of epoch-specific 'problems'.

Electricity is also the topic of the following contribution by **Peter Heering**, professor of physics, its history and teaching: „Batterien aufladen und andere Metaphern in und aus der Elektrizitätslehre: Einige Anmerkungen". The author discusses

metaphors that can be found in the natural sciences as well as metaphors in common language that refer to scientific terms. He focuses on metaphors that were introduced in the field of electricity during the 18th century and which result from this area respectively, demonstrating that metaphors were particularly introduced during the development of the conceptual understanding in a field. Just as several metaphors originate from the same area of knowledge, several metaphors that are used in common language are likewise connected with each other both in the scientific area and in everyday language. Heering shows that some metaphors originate from a conceptual domain whilst others are related to practical performances, a fact that scientists nowadays are often no longer aware of.

The next contribution is by **Anke Beger**, researcher in English linguistics: "Different Functions of (Deliberate) Metaphor in Teaching Scientific Concepts" deals with the use of metaphors in educational contexts. Applying Steen's (2008, 2010) concept of deliberate metaphor, her study takes a new approach on the function of metaphor in academic discourse. Since due to a lack of clear identification criteria, the notion of deliberateness is still contested among metaphor scholars, Beger's contribution also further explores different linguistic realizations of deliberate metaphors. In four US-American college lectures, deliberate metaphors were identified and their particular discoursive functions were analyzed. The results show how the professors use deliberate metaphors as tools for teaching scientific concepts in different subjects. While mediation of scientific knowledge is mainly achieved by the metaphors' explanatory function, some deliberate metaphors exhibit affective functions (e.g., humor) or interpersonal functions. Jointly, these functions of deliberate metaphors further the communication of knowledge in the academic lectures.

This is followed by a contribution co-authored by **Martin Döring**, former linguist, now researcher in the areas of science and technology studies and geography, and **Regine Kollek**, professor for technology assessment and the sociology of science in medicine and neurosciences: „Was ist ‚Leben'? Zur metaphorischen Rahmung eines grundlegenden biologischen Konzepts in der Systembiologie". Taking the current advent of systems biology seriously, their contribution investigates the metaphorical framing of the basic notion of 'life' among German systems biologists in order to

understand which scientific, technological, social and cultural imaginations engender it with meaning. The aim is to prove that the analytical approach allows an empirically saturated, fundamental insight into different conceptualisations of 'life'. This could be the starting point for the development of a 'critical metaphor assessment', providing a well-founded meta-knowledge for critical self-reflection of implicit assumptions, and contribute to a better understanding of the implications of metaphorically condensed experiences of epistemic cultures for science and society.

Life Sciences is also the field that the final contribution by **Bettina Bock von Wülfingen**, researcher in cultural studies and sociology, investigates: „Das Genom als Text: Die Schriftmetapher revisited" falls into line with the previous contribution, as it is devoted to the reproduction of life, focusing on discourse about reproductive technologies. Bock von Wülfingen explores 'text'-metaphors that are salient in genetics and genomics, but are used with pedagogical functions in public media. This became especially apparent during the Human Genome Project, as earlier analyses show. Since in genomics, in contrast to genetics, metaphors drawing on 'text' as in the book and 'text' as in a computer code appear similarly often, the author examines these metaphors and asks: Is the step from genetics to genomics apparent in the metaphors? And in what ways does the history of the text-metaphor indicate specific functions of these metaphors in today's public media? The article discusses the hypothesis that the use of a metaphor as a technical term is in conflict with its use in the non-expert public.

Quite a while has passed now since the Flensburg workshop. Not all the papers presented back then have made it into this volume, and those that have seem to have morphed considerably since then, in some cases due to the inspiration received from some of their colleagues. Thus, even if not all our hopes for an even more intense exchange and synergy between all participants have materialized, we as organizers can still look back at that event with some satisfaction, and present substantial results now as editors of this volume with a big note of thanks to all our contributors. Even if some of them are explicitly interlinked with each other, the contributions in this volume are probably still as heterogeneous as the complex relations between science and metaphor, with each of the authors outlining and presenting their individual

approach to and take on the common topic. But it seems safe to say that, without any claim to completeness, collectively they still represent a truly interdisciplinary perspective on that fascinating and inexhaustible topic: science and metaphor.

Olaf Jäkel, Martin Döring and Anke Beger
in the autumn of 2016

References:

Beger, Anke / Jäkel, Olaf (2015): "The cognitive role of metaphor in teaching science: Examples from physics, chemistry, biology, psychology and philosophy", in: *Philosophical Inquiries* 3 (1), 89-112.

Black, Max (1954): "Metaphor", in: Black, Max (1962) *Models and Metaphors: Studies in Language and Philosophy*, Ithaca/New York, 25-47.

Hesse, Mary B. (1966): *Models and Analogies in Science*, Indiana.

Jäkel, Olaf (2003): *Wie Metaphern Wissen schaffen: Die kognitive Metapherntheorie und ihre Anwendung in Modell-Analysen der Diskursbereiche Geistestätigkeit, Wirtschaft, Wissenschaft und Religion*, Hamburg.

Justi, Rosaria / Gilbert, John (2006): "The role of analog models in the understanding of the nature and models in chemistry", in: Aubusson, Peter J/ Harrison, Allan G./ Ritchie, Stephen M. (eds.): *Metaphor and Analogy in Science Education*, Dordrecht, 119-131.

Kuhn, Thomas S. (1962): *The Structure of Scientific Revolutions*, Chicago/London.

Lakoff, George (1993): "The contemporary theory of metaphor", in: Ortony, Andrew (ed.): *Metaphor and Thought*, 2nd edition, Cambridge, 202-251.

Lakoff, George / Johnson, Mark (1980): *Metaphors We Live By*, Chicago.

Mayer, Richard E. (1993): "The instructive metaphor: Metaphoric aids to students' understanding of science", in: Ortony, Andrew (ed.) *Metaphor and Thought*, 2nd edition, Cambridge, 561-578.

Steen, Gerard (2008): "The paradox of metaphor: Why we need a three-dimensional model of metaphor", in: *Metaphor & Symbol* 23 (4), 213-241.

Steen, Gerard (2010): "When is metaphor deliberate?", in: Alm-Arvius, Christina / Johannesson, Nils-Lennart / Minugh, David (eds.) *Selected Papers from the 2008 Stockholm Metaphor Festival*, Stockhom, 43-63.