# CONTEXTUALIZING PHYSICS: DIFFERENCES IN GENDERED VISIONS

**Cathrine Hasse**

*The question on how to transform higher education within science must be connected to the question of what moves science ahead in the first place. In the paper I introduce the method of anthropological fieldwork, understood as a positioned learning process, as one way of obtaining insight in the processes that keep science and education on the move in higher educational institutions.*

*These processes I believe can be connected to scientific visions understood as the "proximal developmental zones" (Vygotsky 1978) of science driving science forward driven by envisioned future scientific outcomes. From a fieldwork among physicists and students at an institute for physics studies in Copenhagen I shall argue that this process can be seen as gendered. Female physicist students seem to envision their future as physicists in different ways as do male students – being more concerned with the planet earth and its immediate surroundings, whereas the male physicists and students seem to be interested in far away galaxies, the origin of space, and science fiction like themes as space travels and time machines. From this point of departure I shall discuss the implication of gendered interests in science for the future visions of science.*

*Il problema di come far evolvere l'istruzione superiore scientifica deve essere strettamente connesso in primo luogo alla questione di cosa fa nascere lo stimolo a far ricerca. In questo lavoro mi servo del metodo di studio antropologico (visto come un processo di apprendimento) come un modo per capire meglio i processi di evoluzione della scienza nell'educazione superiore.*
*Penso che tali processi possano essere collegati a modi di percezione della scienza come "aree di sviluppo futuro" ("proximal developmental zones", Vygotsky 1978), percui la visione di futuri sviluppi scientifici porta al progresso della scienza. In seguito ad un'indagine sviluppata su un campione di fisici e studenti di un Istituto di fisica di Copenhagen, posso sostenere che tale processo può essere visto come dipendente dal genere. Le studentesse di fisica sembrano vedere il loro futuro da fisici in maniera differente dagli studenti di sesso maschile: le prime sono più preoccupate dello studio del pianeta terra e dintorni, mentre i fisici e gli studenti maschi sembrano più interessati allo studio delle galassie e dell'origine dello spazio, a temi fantascientifici quali i voli spaziali e le macchine del tempo. Partendo da questa constatazione, svilupperò le implicazioni che le differenze degli interessi legati al genere nel settore scientifico hanno nella scienza e nel futuro sviluppo delle scienze.*

Science has, during the past 20 years, increasingly become an established object of study. In general this huge research area of philosophical, psychological, historical, sociological, anthropological approaches to science studies can be summarized in the appellation STS (Science and Technology Studies) or SSK (Social Studies of Scientific Knowledge)[1]. Researchers from the Humanities and the Social Sciences have in increasing numbers entered the laboratories, watched scientists watching experiments (see for example Latour 1986 (with Woolgar), 1987, Pickering 1992) and undertaken historical studies (see for example Shapin 1982) mainly with the aim of uncovering the social aspects of the practices in natural sciences. This article aims at examining a puzzling area in these science studies -the gendered aspects of scientific practice.

The point of departure for my research has been a scientific inquiry into the question: do science have gendered dimensions? Many scientists would immediately say no.

Yet we find some unexplained gender differences. In many countries in Western Europe and USA very few women get to the top in the natural sciences. One explanation could be that careers in the natural sciences for some reason or other are harder to obtain by women - here all kinds of "*folk-reasoning*" make up plausible reasons; from childbirth to women's lack of "*scientific thinking*". On this background it is curious that in Italy we find that women obtain slightly more than half of the natural science degrees (55 percent), whereas in the Scandinavian countries only a small percentage of total female university

[1]Some translate STS as "Science, Technology and Society".

degrees are earned in the field of science and in England it is 27 percent. We also find similar surprising and significant gender differences between Eastern and Western European countries (Science1994). A closer look at the discipline of physics shows similar differences in science careers: in Italy about 23 percent of the physics professors are women compared with 3 percent in the United States (NSF 1996). In Denmark, where I have made a fieldwork among physicists and physicist students at university level, we find less than 1 percent female professors and less than 5 percent female academic staff in general. What I found here, though, was a tendency for the female staff and students to "*lump*" themselves together in certain departments of physics - mainly geophysics and astrophysics (Hasse 1998). Interviews with male and female scientific practitioners within different disciplines in Denmark and the United Kingdom revealed further differences in the ways male and female scientists seemed to relate to their object of study and envision the future outcome of their work as scientists. Taken together these data could point to a possible importance of gender in relation to physics.

## SCIENCE AS CULTURE

To claim such a connection is in many ways hazardous. Not only is it very hard to make plausible as there are as yet no fully developed research tradition for this particular scientific perusal - the questioning of the "pure" interests behind scientific inquiry might also be seen as problematic. The positivist notion that scientific objectivation of nature can be clearly demarcated from the observing subject has for long been challenged not least by the scientists themselves, though. Among others the Danish physicist Niels Bohr has underlined that there can be no sharp division line between subject and object as also the object is part of our mental equipment. Pointing to the possible different ways scientists contextualize their objects of study might bring this discussion a little further.

Robert Merton saw scientific practice as ideally driven by CUDOS = Communism, Universality, Disinterestedness and Organized Skepticism (Merton 1942). These scientific norms would secure "*communal*" exchange of scientific information, that science worked independent of gender, race, age and the like, that scientists would only be guided by honest and objective reasons, that no personal interests, profits or ideologies would interfere with scientific endeavors and finally that science should build on a profound skepticism of authority. Science could therefore ideally be seen as lifted out of any cultural context (Merton 1942). In practice many studies have shown that science works far from these ideals –and many of these studies point out cultural differences.

The first to point to science, as culture was C.P. Snow who, with regret, had to point out the cleft between the natural and human sciences as "*two cultures*" (Snow 1964). Snow was not talking about national culture, but of the two general cultures of literary intellectuals in human science and scientists in the natural science. Culture was defined in two ways as "*intellectual development of the mind*" and "*as used by anthropologists for at group of persons living in the same environment, linked by common habits, a common way of life*" (Snow 1964:62-64).

Since then it has become more common to describe different areas of scientific practice as "*cultures*" even within the two scientific cultures, though this kind of argumentation is still in the making. The German scholar Karin Knorr-Cetina has conducted one such study. Through micro studies of scientific practices she finds differences in science epistemology connected to scientific equipment and measurement standards within two separate areas within the natural sciences (Knorr-Cetina 1991).

These kinds of studies have tended to ignore that sciences (natural as human) are also embedded in national and historical contexts that provide scientists with different backgrounds even when they work within the same area. Comparative studies of the "*same*" scientific practice in two different national cultures have only, to my knowledge, been conducted once before -namely in the American anthropologist Sharon Traweeks seminal study of one group of Japanese and one group of American physicists in "*Beamtimes and Lifetimes. The World of High Energy Physicists*" (Traweek 1988).

Such projects have on the other hand overlooked the influence of nationally based education and national funding systems on the cultural constitution of social practice and the scientist's subjective cognizance.

The scientist closest to this awareness of the importance of education for the physical

science is the science historian (an originally physicist) Thomas Kuhn who, in his many studies in scientific tradition and change, has underlined that science not only is about the relation between a subject (the scientist) and a (natural) scientific object, but involves the process through which we learn to recognize the object as scientific. This, among other things, involved the pointing to *"best exemplars"* whereby the students learn from the teacher and researcher what aspects to give importance to and what to overlook (Kuhn 1962, 1977). Kuhn, on the other hand, was more interested in paradigm shifts *within* a discipline (as physics) than in cultural differences, the social driving forces and the culturally informed practice of the positioned subject[2]. Through education scientists, already as students, learn to contextualize –and therefore understand– physics in certain ways. This is how paradigms are maintained. The next question becomes if we can find gender differences in the ways students contextualize physics in the learning cultures of higher educations.

## LEARNING CULTURE AS CONTEXT

Whereas Traweek aimed at a comparative study at the laboratory level between physicists from two different cultures understood as national cultures, and Kuhn's work aimed at showing how physicists students became part of and parcel with paradigmatic thinking, I have studied gender differences within the same Danish educational culture at the Institute for Physics in Copenhagen.

Culture is the *sine qua non* of anthropology. Recently the concept has been deconstructed as connected to place and nation states in a naïve way (see Olwig&Hastrup 1997). What we name "*culture*" is rather to be understood as an intricate pattern to appear in the cultural analysis (Hastrup 1995). Anthropology as such can be seen as the study of how "*other*" people contextualize physical space in different culturally informed ways –even within nation states (Hasse 2000). Culture is thus seen as equivalent to context. Contexts can be defined as the more or less shared framework we use to interpret and relate to the physical objects around us and how we communicate about them. The anthropologists Gregory Bateson has put it this way:

*"The difference between the Newtonian world and the world of communication is simply this: that the Newtonian world ascribes reality to objects and achieves its simplicity by excluding the context of the context - excluding indeed all metarelationships- a fortiori excluding an infinite regress of such relations"* (Bateson 1972:250). In contrast many anthropologist will insist on studying "*metarelations*" –which can be understood as studying patterns in peoples culturally informed ways of knowing and relating to a physical space and their actions in practiced place (cf. Certeau 1984:117). Very briefly: we study culture as context.

This points to a further understanding of the cultural learning processes through which the scientists have learned to contextualize the scientific activity of physics. What scientific questions do they ask, how do they explain what they are doing, and why it is important? In other words: How does one learn to become member of a *"physicist culture"* and subsequently: do we learn to contextualize physics in the same way regardless of gender? At the Niels Bohr Institute for Physics in Copenhagen I followed a group of new coming freshman students through their first years of study (from 1996-1998). Part of the study dealt with how the students approached physics in different ways and further developed different attitudes towards the object of physics.

Whereas much attention has been given to either what we understand by a *"subjective experience"* (see for example Zahavi 2000) or power relationships through which human beings are made into subjects (see for example Foucault 1984), I have focused on the relation between an already established community of practitioners (the scientists) and the way their actions and discourse mediate between objects and the newcomers (the anthropologistsherself as well as students and Ph.D.-students). I made use of what can be divided as four different methods that were not only interconnected and triangular (Denzin op.cit Patton 1990:187) but stood in a hierarchical relationship. First of all I made use of what can be termed positioned participant-observation understood as filling out a social category as an ethnographic newcomer available in the cultural space to be occupied and learning in cultural ways from this position. Learning as a positioned participant observer does not mean

[2] For a further discussion of the scientist as a positioned subject see for example Haraway 1991, 1995

that I, who after all am educated as an anthropologist, pretend to be (or to become) a physicist, but that I participate in the same activities as much as I can from my limited abilities as the other newcomers, and that it is from this position I make my observations and reflections. There are many problems by following the method of positioned participant-observation. Many impediments can stand in the way of participation (see Hasse 2000 for further clarification). All the same the participant-observations form the constantly changing and forthcoming resource for my use of two other methods: surveys and interviews. Interviews and surveys were made, with students, teachers, and scientists to enhance and clarify points made in the analysis made from participant-observations. The participant-observation in the same activities as the people to be interviewed further ensures that we do not only meet in the "*researcher-made*" context of making-an-interview, but can build up a common language through participation in the same daily practices. Finally the analyses made from the above mentioned methods resulted in presentations for the involved physicists, which formed a sort of feedback loop between participation and analysis (Hasse 2000).

The main focus on cultural learning processes implies changing basis of reflection that gradually make way for new kinds of surprises (Hasse 2000:122-123, Hastrup 1992). Newcomers are disciplined and subjectified in Foucault's panoptic sense (Foucault 1984), ascribed new identities as well as learning a new moral horizon defined not as a property but a space with unfixed boundaries, perpetually subject to expansion or contraction (Hastrup 1995:11). In this process I assume we learn new contextualized relations between the subjects we become, the objects we study and the values we ascribe to both in this particular setting: an institution for both doing science and teaching science. The point here is that the male and female students to some extent seemed to learn to contextualize physics in different ways.

## GENDER-DIVERSITY IN PLAY AND SCIENCE FICTION

If we only stick to studies of textbook learning and measure by the exams the students take, we do not find many gender differences. Women and men perform more or less alike –some good, some not so good. However, participation in class and student life in general taught me that physics studies consists in more than learning textbook physics and that a number of activities that are not apparently connected to the physics study actually act as heuristic devices. One example of this could be the yearly theater show "*Fysikrevy*" where a number of students came together to make funny sketches about daily life at their institute. Though they were making theater and not homework the students engaged in a lot of informal learning situations during rehearsal. Elder students who in that sense acted as informal teachers explained sketches not immediately understandable to the new coming first-year students. Many students also engaged in playful acts -jokingly testing physics theory. They would jump up and down in elevators discussing how the movements of the elevators affected their own gravity, or throw objects at each other discussing the movements with theories learned in class, but here used in a joking manner. Though these episodes were not part of curriculum and the planned teaching of students, the playful activity could be seen as a sort of "*learning by doing*" as John Dewey named it (Dewey 1916). By acting out theories they also learned how they worked. To understand the meaning of the jokes they simply had to learn about the theories. Even though I found it surprising at first to see all the playfulness connected with physics studies I soon came to find it surprising that mostly male students engaged themselves in these activities. Whereas the female students in general studied very hard, and were very good at classroom physics, they rarely engaged in the playful acts.

Another surprise was the interest in science fiction among the students. Many discussions about physics theory ensued from discussions connected to science fiction movies or stories. In many cases the discussions also led to clarifications of how far physics actually had come as a science, and in what direction it should be aiming to fulfill the prophecies in science fiction imaginary. The television series "*Star Trek*" for example seemed a never ending resource for new discussions on warp-speed, space-time issues, wormholes and the like. Again it became surprising that almost no female students participated in these discussions.

A survey among the group of students revealed that there were ended many

differences concerning the general equipment the physicists students brought with them to the physics studies. Though there was no gender difference when it came to grades in physics and ability to solve text book exercise both former experience with science as play (computer play), science fiction and the like revealed itself to be gendered - just as the general explanations of why they wanted to study physics in the first place (Hasse 2001 *in print*, Hasse 1998, 2000). Many female students, contrary to many male students, have not had the experience of playing science fiction computer games with a group of friends nor do they not see science fiction or playing with physics experiments at home as an inspiration for physics studies. These differences can be found within the group of male students too. Though such differences might divide the larger group of male students almost none of the female students participate actively in play with physics and their actions in general seem more linked to education than to play. As play with physics can be seen as connected to science, and female students rarely play this way this could be discussed as one of many explanations of why female physicists do not seem to feel at home in field of science. Following this whole argument it can be discussed if what we can analyze as gender problems could also be approached as problems of premises for participation in activities (Hasse 2001 *in print*). 'Doing physics' seem to be an activity that forms in a relational meeting between a students' former experiences and drive toward a further development (Hasse 2001 *in print*, Hasse 2001).

This points to a further understanding of the cultural learning processes through which the scientists have learned to ask specific scientific questions and relate themselves to their science and it's future perspectives.

## GENDER-DIVERSITY IN DRIVING FORCES

Driving forces I define as forces that pull participants towards their own conceptualizations of a future envisioned through a cultural learning process (Hasse 2000:300-301). These processes take place in everyday life and are very rarely stated explicitly: *why do we do what we do?* Though we do not explain to yourself and others why we discuss this or that movie, study this or that object, read this or that book all of these actions can analytically be seen as connected with future expectations. As Dewey puts it: "*Mind is the capacity to refer present conditions to future results, and future consequences to present conditions*". And these traits are just what is meant by having an aim or a purpose (Dewey 1916/66:103) and this cannot be separated from former experiences: *"(For) every act, by the principle of habit, modifies disposition -- it sets up a certain kind of inclination and desire*"(ibid: 357).

For the male physicist students what pulled them towards a future in physics was often clearly stated in terms of play or a fulfillment of science fiction phantasy. Many also described "*the childish happiness of finding the new*", "*the scrutiny of reality*" and designated their relation to physics as a "*vocation*" and stressed the relation between physics and the relation between physics and philosophy. A number of references among teachers and students were also made to the "*plan of God*" that physicists had a vocation to unravel. Contrary to these statements the women described physics as connected with the mysteries of the earth -but also expressed a more pragmatic approach to physics. They placed themselves in Geophysics because they wanted a good job, and only a few women expressed a drive towards research (Hasse 1998).

In interviews later conducted among the scientists in Denmark and England we find both men and women deeply engaged in their science -but also here we find many male statements about both science fiction and the necessity to be playful in working with physics.[3] Many famous male scientists have written books that connect questions in physics with science fiction -as *The Physics of Star Trek* (Krauss 1995) and *Contact* (Sagan).

One typical male younger physicist researcher describe how he has read hundreds of science fiction novels (starting with Isaac Asimov going to Douglas Adams) and have enjoyed Star Trek and the Dr. Who series on

3 I have interviewed 14 physicists in Denmark and England - 7 females and 7 males. There are not many female physicists. To make sure the females could remain anonymous the interviews have been conducted in two different countries. The younger females know more about science fiction than the elder female physicist, but only one woman of the 7 actually read and enjoyed it herself, whereas all of the male physicists knew about science fiction discussions and five of the male physicists enjoyed it themselves.

television -not especially for the science discussion, but because they are "*very, very funny*". He also explains the needs to have a playful approach to his work with physics and that what drives him is the fun it gives him to work with physics. "*The real joy is creating something which gives satisfaction. There is a philosophical thing to Physics. One of the Labs I worked in has written a quote from the Psalms over the door where it says something like: Great are the works of the Lord and the Joys of those who take Pleasure in it. That sums the whole thing up, I think*." Many male physicists express this "*taking pleasure in the works of the Lord*" as a major driving force in their work - and some even go as far as to discuss how they as physicists "*unravel the great plan of God*". This is actually also the message in the astronomer Carl Sagans book Contact that in 1997 was much discussed among the students I worked with: Here the message is, that the universe is made on purpose and it takes a physicist to figure out that the Creator has designed the universes mathematically (Sagan 1985/1997).[4]

In general women are much more modest and have a more expressed seriousness about their work. They describe themselves, though they do not draw attention to this point, as hardworking scientists who are driven by curiosity but often do not get proper credit for their work. They ask very concrete questions like "*Why do molecules fold like crystals - why do they do that?"* They often leave the theoretical work to other colleagues and they describe themselves as "*more practical workers*". Instead of telling stories about play, science fiction, fun and joy in physics, especially elder female physicist tell stories about being overlooked and overheard. Some of them, especially the elder women, are very attentive to gender differences whereas the males and the younger females deny that gender in itself is problem as it cannot be connected to the actual object of science - though everyone want to see more female physicists in science.

One male physicist answers the question about whether gender is a problem in physics: "*No I don't think it is. There is no difference in the approach to physics. Women make a difference in the social dynamic of the group, though. Women have a civilizing influence*". Even though many of the female physicists I have interviewed would agree, we find some differences in the way they describe their careers in physics. Among the elder female scientists bitterness prevail because they have not been promoted. The three oldest have worked for more than 25 years as physicists -and only one has become a reader- and she express bitterness about never having been appointed professor. Some of those women have left physics for some years to take care of children.

"*You have these 'criteria', you see, and if you have an unsteady career, like me, then you don't fit them. They will say "Oh, she did not have many publications when she was 32 (though she has plenty now)". Well of course I did not: because I was a home, you see. The only women I know who have been promoted to readers are those who do not have any children -they are also very good, but that's the way it is*". None of the male physicists spoke with the same kind of bitterness of their career paths (though some told of hard fights for positions) and none related career to gender.

## CONCLUSION

To epitomize the problem and the argument: from sheer statistics we can note that a number of differences can be found between male and female physicists career wise. When we look at countries like USA, England, and Scandinavia it seems likely that these differences can be connected to the reasons pointed out in "*folk theory*" -**as women take care of children it becomes difficult to pursue careers in physics**. When we look at the differences between genders in physics in Northern, Eastern and Southern Europe this explanation does not seem sufficient-as many more women both study and get tenure in these countries. Though babies still might play some part, **children cannot be the whole explanation** why women lack behind in physics.

A closer look into the practice of physics within one of the Scandinavian countries, Denmark, reveal signs of ***differences in terms of research interests*** and in terms of playing with physics and discussing "*doing physics*" in relation to science fiction or "*the plan of God*". These differences can be analyzed as differences in the ways scientists-to-be and scientists contextualize physics and what drives them to make science -a tendency that is somewhat confirmed by interviews among Danish and English physicists. **Women seem**

4 What makes the discussion a little confusing is that when many physicists, like Carl Sagan, speak of the Creator (or even of God) they do not mean the Cristian God but precisely "the Creator" the masterplanner.

**to have a very serious and hardworking approach** towards doing physics and work with concrete and sometimes even literally "*down to earth*" questions, whereas male scientists seem to have at the same time a more "*easygoing*", fun and pompous approach to their work.

From the meager material presented and collected not much can be concluded, though. What we can do from this discussion is conclude that much more research is needed before we can be sure that science is *not* gendered -and that cultural differences in male and female experiences do *not* lead to gendered differences in scientific visions. Of course these differences are what feminists like Sandra Harding, Donna Haraway and Evelyn Fox Keller have discussed for many years where the point of departure have been a realization that science is a *"Western, bourgeois and masculine"* project (Harding 1991, Haraway 1991). Though feminist positions have evolved and changed perceptions over the years, our stereotypes of science as mainly for males seem to be stuck in deep mental configurations. "*Science*", declared the feminist Evelyn Fox Keller's five-year-old son once, "*is for men*!" Fox Keller goes on to state, that her son simply expresses the identification between scientific thought and masculinity so embedded in culture that children have little difficulty internalizing it, (Keller 1985, 77). This leaves us with the question of what happens when more women work in the sciences -as they do in Italy. Will we find different "*culture of learning*" when we go from one European country to another? Are different values and norms permeating the research cultures? How this might be related to the gender question remains to be seen.

## LITERATURE


Adams, Douglas (1995/1979) *The Hitchhikers guide to the Galax,*. Ballentine: New York

Certeau, Michel de (1984/1988) *The Practice of Everyday Life*, Berkeley: University of California Press

Haraway, Donna (1991) *Simians, Cyborgs and Women*. Free Association Books. London.

Hasse, Cathrine (2001) Institutional Creativity - The relational zone of proximal development. Forthcoming i tidsskriftet *Culture & Psychology*, SAGE Publications in CAP 7(2) 2001 (June issue).

Hasse, Cathrine (2000) Kraftfeltet - kulturelle læreprocesser i det fysiske rum. Ph.d.-afhandling. Institut for Antropologi. Udkommer som bog med titlen "Kulturelle læreprocesser" Forlaget Samfundslitteratur. København

Hasse, Cathrine (2000) Feedback-loop among Physicists - Towards a theory of relational analysis in the field. *Anthropology in Action*, 3/2000, pp. 5-12.

Hasse, Cathrine (1998a) *'Learning to pattern physicist virtues: male and female dissimilarities'.* In *Justification and Enrolment Problems in Education Involving Mathematics or Physics*. Jens Højgaard Jensen, Mogens Niss and Tine Wedege (eds.). Roskilde. Roskilde University Press.

Hasse, Cathrine (1998b) *Kulturelle forestillinger og køn i videnskabens samfund. Portræt af en gruppe fysikstuderende- med antropdog*. Arbejdespapir nr. 4 Køn i den Akademiske Organisation. Red. Inge Henningsen. Copenhagen: Det Samfundsvidenskabelige Fakultets Reprocenter..

Hastrup, Kirsten (1995) *A Passage to Anthropology - between experience and theory*, London: Routledge.

Knorr-Cetina, Karin (1991) "Epistemic Cultures: Forms of Reason in Science," in *History of Political Economy*, 23, Spring, pp. 105-22.

Kuhn, Thomas S. (1962/1963) *The structure of scientific revolutions* Chicago : The University of Chicago Press

Kuhn, Thomas (1977) *The Essential Tension*, Chicago: The University of Chicago Press.

Krauss, Lawrence M. (1995) *The Physics of Star Trek*, New York: BasicBooks

Latour, Bruno (1987) *Science In Action. How to Follow Scientists and Engineers through Society*, Cambridge Mass.: Harvard University Press.

Latour, B., & Woolgar, S. (1986). *Laboratory Life: The Construction of Scientific Facts.* Princeton, NJ: Princeton University Press.

Lave, Jean (1993) *'The practice of learning'* in S. Chaiklinand J. Lave eds.*Understanding practice. Perspectives on activity and context*., Cambridge:Cambridge University Press.

Lave, Jean (1999) *'Læring, mesterlære, social praksis'*, in K. Nielsen og S. Kvale (eds.) *Mesterlære - Læring som social praksis*, København: Hans Reitzels Forlag.

Lave, J., & Wenger, E. (1991) *Situated Learning, Legitimate Peripheral Participation*, Cambridge: Cambridge University Press.

Merton, Robert (1942) "*Science and Technology in a Democratic Order*" Journal of Legal and Political Sociology 1 (1942), 115-26

Nature (1997) 13. vol.: 390.

Patton, Michal Quinn (1990) *Qualitativew Evaluation and Research Methods* London Sage Publications.

Pickering, A., ed.(1992) *Science as Practice and Culture*. Chicago: University of Chicago Press

Sagan, Carl (1989/1974) "*Science Fiction - a Personal View*". In *Broca's Brain - reflections on the romance of science*, New York:Ballentine Books. pp.162-174.

Sagan, Carl (1985/1997) *Contact* New York: Pocket Books Pub.

Science (1994) *Surprises across the Cultural Divide in Science.*11. March 1994. Vol. 263. pp.1468-1472.

Shapin, S. (1982) "History of Science and Its Sociological Reconstruction." *History of Science*, 20: 157-211.

Snow, C.P. (1964) *The two Cultures and a Second Look*, Cambridge: Cambridge University Press

Traweek, Sharon (1988) *Beamtimes and Lifetimes. The World of High Energy Physicists*., London : Harvard University Press.

Zahavi, Dan (2000) (ed) *Exploring the Self. Philosophical and Psychopathological Perspectives on Self-experience.* Amsterdam-Philadelphia.



## CATHRINE HASSE

*Danish anthropologist specialized in studies of cultural learning processes in science. She is presently holding a position as a Senior Research Fellow, at the Danish Institute for Advanced Studies of the Humanities.*

***Contatti:*** *Vimmelskaftet 41A, 2 DK-1161 Copenhagen K Denmark*

*Phone +45-35-323920* *Fax +45-35-323915* *Email Cathrine.Hasse@humanities.dk*