

Sabine Zubarik

Literature and Quantum Physics A Synopsis

In 1959, when Charles Percy Snow lamented the gap between natural sciences and humanities in his lecture “The Two Cultures and the Scientific Revolution”¹, it was followed by persistent debates about the two cultures and many responses that attempted to find a mediation. Some scholars were looking for a third culture that could provide the missing link. One of them is John Brockman, who in 1995, – 40 years after Snow’s lecture –, announced popular sciences (that were continuously growing over the last decades) as the crucial synthesis.² This does not seem out of place, considering the mass of new books about the development of natural sciences in the 20th century, written in a commonly comprehensible manner, that are published annually and see their second edition as soon as the second year. Popular scientists like Stephen Hawking, Brian Greene, John Gribbin and Paul Davies have long since been placed in the average home’s bookcase and are definitely read by non-scientists. Meanwhile it is almost part of a successful career as a famous physicist to write a popular scientific book (which by the way is on no account a phenomenon of

¹ Snow, *The Two Cultures and the Scientific Revolution*, 1959.

² Brockman, *The Third Culture*, 1995.

Northern America: also the Austrian particle physicist Anton Zeilinger³ or Brigitte Röthlein⁴ in Germany amongst many others have offered their share in this field). The fact that these books also show a certain amount of literariness and poeticity, cannot be neglected: They are full of metaphors, literary allusions, poetical images and rhetoric devices, and in case the clarity of the physical model is not achievable by means of scientific language, the modern physicist-didact is not shrinking from explaining the state of affairs analogously with the aid of a fairytale or a story. The examples are many but not of our nearest focus here. Nevertheless these phenomena should be of high interest to literary studies. Dirk Vanderbeke has done important work on this by comparing the indescribability in literature, using the outstanding example of *Finnegans Wake*, with the indescribability of the insights of modern physics.⁵ For one thing, says Vanderbeke, is common in modern literary texts and in descriptions of quantum physics: it is only traces that can be examined, signs that are left by an inapproachable referent.

The lasting debate about Snow's conclusion of the two cultures and the simultaneous growth of the apparently general interest – as the book market shows – in quantum physics and its philosophical implications, point to a status quo, where cultural sciences, and even more so literary studies, are lagging behind the actually present interest. The changes of the new physics in the 20th century and the involved fundamental shift in our understanding of the world and its realities are not sufficiently (or not sufficiently interdisciplinary) dealt with in academic theories. Elisabeth Emter, who investigated the explicit synthesis of natural sciences and cultural

³ Zeilinger, *Einsteins Schleier*, 2003. *Einsteins Spuk*, 2005.

⁴ Röthlein, *Die Quantenrevolution*, 2004. *Schrödingers Katze*, 1999. *Das Innerste der Dinge*, 1998.

⁵ Vanderbeke, *Wörter man nicht sprechen kann*, 1995.

sciences in intellects of German authors from 1920 to 1970 in their theoretical writings (as Gottfried Benn, Ernst Jünger, Robert Musil, Elias Canetti und Hermann Broch), proves the direct impact of the modern physicist's world view on the philosophical thinking of the authors.⁶ She, too, claims the shortage of surveys:

[M]ehrere Einzelanalysen können nicht darüber hinwegtäuschen, daß eine umfassende Untersuchung des direkten Einflusses naturwissenschaftlicher Erkenntnisse auf die Literatur und Ästhetik der Moderne mittels Lektüre, Translation und Transformation naturwissenschaftlicher Theorien bislang versäumt wurde. Wenn man die reichen Forschungsergebnisse zur Wechselbeziehung zwischen den klassischen Naturwissenschaften und der Literatur des 18. und 19. Jahrhunderts betrachtet, verwundert es um so mehr, daß die Einflüsse der modernen Naturwissenschaften auf die Ästhetik und Literatur im 20. Jahrhundert nur unzureichend erforscht sind.⁷

Beginning in the thirties, one can detect a noticeably strong attention towards physics, particularly the theory of relativity and quantum mechanics, in the choice of motifs in literary texts, and this is by far not only true for science fiction or fantasy literature, which explore scenarios of horror or utopias of new possibilities facilitated by highly developed science and technique, but also in other genres of literature (as the above mentioned research of Emter is

⁶ Emter, *Literatur und Quantentheorie*, 1995.

⁷ Emter, 1995, p. 8-9. English translation of German quote (by SZ): “[...] several singular works of analysis cannot hide the fact that an extensive research of the direct impact of scientific understanding on literature and aesthetics of modern age via reading, translation and transformation of theories of natural sciences are so far missing. Regarding the rich results of surveys about the interrelations between classical natural sciences and literature of the 18th and 19th century, it is all the more astonishing that impacts of modern natural sciences on aesthetics and literature in the 20th century are only researched insufficiently.”

showing). But there is a lack of discourse in terms of literary theory. This lack of research is starting now – meaning continuously since the early nineties – to be filled. With the temporal postponement of 20-50 years that seems necessary in general to acknowledge and describe a literary change, phenomenon, motif or a new style of writing, since the 90s literary studies now also begin to investigate in a more extensive way the impact of quantum physics on authors and their new specific way of writing.

How can literature – and therefore as well literary studies – deal with insights of quantum physics?

It can be done in terms of motifs. In this category are works that deal with physicists and their situation and social responsibility in the first half of the 20th century, – one can think about Dürrenmatt and his theatre play *Die Physiker*.⁸ All narrations, novels and films concerning time travels, inspired by the understandings of the theory of relativity, or later dealing with the many-worlds theory, also count among this category. Jorge Luis Borges with his *Ficciones*, (especially the story ‘El jardín de senderos que se bifurcan’⁹) is definitely worth mentioning in this context, but also recent films that are devoting their attention to the question of causality, as for example *The Butterfly Effect*¹⁰ or *Dejá Vu*¹¹.

The Irish author Flann O’Brien¹² deals with modern physics of his time in a very differentiated manner in his novel *The Third Policeman*, which was produced in the 40s but only published in 1967.¹³ Jürgen Meyer examines very comprehensibly in his book *Allegorien*

⁸ Dürrenmatt, *Die Physiker*, 1962.

⁹ Borges, *El jardín de senderos que se bifurcan*, 1941.

¹⁰ *The Butterfly Effect*, USA 2004.

¹¹ *Dejá Vu*, USA 2006.

¹² Flann O’Brien is a pseudonym, his real name was Brian O’Nolan.

¹³ O’Brien, *The Third Policeman*, 1967.

*des Wissens*¹⁴ the connections of the events and the narrative dispositions in the novel with O'Briens critical attitude towards and his resulting parody of the public reception of physical novelties in Dublin in the 30s after the inauguration of the DIAS institute, where also Erwin Schrödinger functioned as one of the leading figures.

In 1995, Emter emphasizes: If modern natural sciences are dealt with at all in literary analysis, it is mainly with the focus on science criticism.¹⁵

So far for the level of motif.

Let us go a step further with literary texts in which the physical motif has actual effects on the procedure of writing. Correspondingly, this is more interesting for literary studies. An extremely good example for this is the novel *En busca de Klingsor* by the Mexican author Jorge Volpi, published originally in Spanish in 1999.¹⁶ Dealing with the search of an American spy for the physicist who is hidden behind the pseudonym Klingsor and who is said to have been pulling all the strings of science in Germany during the Third Reich, physics' terms like the uncertainty principle, quantum leaps or antilinearity are not only talked about in the story, but can also be found in the structure of the narration. One only has to see the table of contents with the titles of all chapters in order to get a clear picture of the relationship between the events of physics and the narrative structure: The first main chapter is entitled "Laws of Narrative Motion", with the minor chapters "Law I: All narratives are written by a narrator", "Law II: All narrators offer one, singular truth" and "Law III: All narrators possess a motive for narrating".

¹⁴ Meyer, *Allegorien des Wissens*, 2001.

¹⁵ Emter, 1995, p. 6: "Wenn die modernen Naturwissenschaften in literaturwissenschaftlichen Analysen thematisiert werden, so vor allem unter dem Gesichtspunkt der Wissenschaftskritik."

¹⁶ Volpi, *En busca de Klingsor*, 1999. English translation: *In Search of Klingsor*, 2002.

The second part of the book is organized in five hypotheses, followed by five disquisitions as minor chapters of the third part. Many of the chapters have titles that combine scientists with certain life situations, as for example “On Einstein and Love”, “On Gödel’s Theory and Marriage”, “Max Planck, or a Lesson in Faith”, “Werner Heisenberg, or a Lesson in Sadness”, “Niels Bohr, or a Lesson in Will”, and so on.¹⁷ Volpi turns narrating into an experiment on the establishment of truth by mathematical and logical convergence, only that in the end the establishment of a precise solution fails at exactly the same point where classical deterministic physics also comes to an end on the subatomic level: undecidability and therefore undescribability.

In Albert Goldbarth’s novel *Pieces of Payne*¹⁸, topics like division, bifurcation, complementarity and also the quantum leap are discussed and at the same time put into practice on the structural level of the narration. The novel is composed of mainly¹⁹ two parts, the narration of a dialogue between two persons in the first half of the book, and in equal length an apparatus of annotations, in which the inserted notes are collected as short chapters. They include quotes from literary works, biographical details of famous and not so famous people, excerpts from newspaper articles, information about astronomy, physics, biology, and so on, which are implemented into the dialogue by the narrator. The reader constantly finds himself in the position to change back and forth between two complementary but also interwoven parts. Each bifurcation, evoked by the marking of an end note in the text, demands a decision from him or her. The individual annexed texts behave “quantical”, they are

¹⁷ Volpi, 2002, p. IX-XI.

¹⁸ Goldbarth, *Pieces of Payne*, 2003.

¹⁹ I say “mainly”, because in the epilogue and the acknowledgements the novel actually goes on, enclosing further text fragments, adding another layer to the commentary notes and therefore presenting *Pieces of Payne* as a work that is in principle never-ending and infinitely expandable.

not directly connected with each other as one linear text; the link from one to the other does not textually exist but takes place only in the association work of the percipient reader.²⁰

Further examples are numerous, but these two shall be enough.

It seems to be particularly daring, but also particularly fruitful to deal with literature and quantum physics in a way that transfers insights and especially models of natural sciences to the analysis of writing styles in literary works that are not explicitly or necessarily dealing with physics. This is risky because for non-physicists there exists the danger to not really grasp the specific quantum physical state of affairs and to jump hastily to philosophical conclusions and implications for the macro-cosmos with phenomena that actually describe the subatomic level; in addition, metaphors that are used by physicists themselves for illustrations are sometimes generalized or transferred incorrectly. Still one should risk the experiment, because it seems to be productive to analyse literary texts with physical insights, as has been done with statements from classical physics. One can think for example of the great interest and many analytical surveys in connection with the second thermodynamic theorem, meaning entropy.

Before we can actually try this with text examples, we must pose the question, what kind of paradigm shift new physics of the 20th century has initiated and why exactly this opens up a significant common ground with literature. To be more specific: Why does quantum physics offer new starting points for an analogy between poetological methods and understandings of natural sciences? What exactly are those new findings that changed our world view and accordingly our philosophy and literature? Why is it that in this era of quantum physics and theory of relativity authors are narra-

²⁰ A more detailed analysis of *Pieces of Payne* in the context of “quantum” writings can be found in the following article: Zubarik, ‘Rhizomatisches Schreiben (und Lesen): Albert Goldbarths *Pieces of Payne*’, 2008.

ting and particularly writing differently?

New Physics

An overview at this point must be sporadic, quantum physics of course cannot be summarized in three sentences. So, here are a few of the most important items:

- Planck's experiments on black body radiation around 1900 and the resulting discovery of quantifiability of light contradict the discoveries with the double slit experiment that prove light to be a wave. The fact that light – and not only light, but also, as has been proved, other particles – can be regarded as particles as well as waves, depending on the set-up of the experiment, represents an irreconcilable contradiction and a paradox against the Aristotelian law of logic “*tertium non datur*”. This is an aspect of complementarity: Wave and particle as forms of description are each in and of itself merely partly true, only as an inseparable whole that takes both into consideration, can physical reality be entirely portrayed. A demand for the unity of inconsistencies is the consequence.

- The quantum leap of the electron to a lower energy level and the accompanying emission of a photon can only statistically be calculated in terms of time. The fact that on the subatomic level there are processes that only can be predicted statistically but not exactly calculated, introduces the term of objective coincidence into the science of physics (the difference between subjective and objective coincidence is that the first is only a coincidence for the observer because he does not know the preconditions, but the event still is bound to causality; the second in contrast is inherent in nature).

This means the end to determinism and the idea of the so called clockwork universe that once set in motion proceeds as preordained and would be totally predictable for us if only we had all data and possible calculations – as was postulated for example by

Pierre Laplace in the 19th century. Heisenberg on this:

Aber an der scharfen Formulierung des Kausalgesetzes: 'Wenn wir die Gegenwart genau kennen, können wir die Zukunft berechnen', ist nicht der Nachsatz, sondern die Voraussetzung falsch. Wir *können* die Gegenwart in allen Bestimmungsstücken prinzipiell *nicht* kennenlernen.²¹

- The uncertainty or indeterminacy principle says that position and velocity of a particle cannot be measured at the same time. This is the end for Newton's axioms of motion on the subatomic level.
 - With of Einstein's theory of relativity on the one hand and wave-particle duality on the other, the terms energy and matter cannot be seen dichotomically, but must be thought of as two states of the same thing. Davies and Gribbin announce the "death of materialism": "Quantum physics undermines materialism because it reveals that matter has far less 'substance' than we might believe."²²
- Therefore, indeterminism is the main characteristic of quantum physics:

The old physics linked all events in a tight chain-mesh of cause and effect. But on the atomic scale the linkage turns out to be loose and imprecise. Events occur without well-defined causes. Matter and motion become fuzzy and indistinct. Particles do not follow well-defined paths, and forces do not produce dependable actions. The precision clockwork of classical Newtonian mechanics gives way to a ghostly melee of half-forms.^[1] It is out of this submicroscopic ferment that the essential quantum

²¹ Heisenberg, 'Über den anschaulichen Inhalt der quantenmechanischen Kinetik und Mechanik', 1927, p. 197. English translation (by SZ): "But of the keen formulation of the causality law: 'If we knew the present exactly, we could calculate the future', it is not the conclusion that is wrong, but the premise. In principle, we *cannot* know the present in all its determining parts."

²² Davies, Gribbin, *The Matter Myth*, 1992, p. 11 and 14.

uncertainty emerges. What happens from moment to moment cannot be predicted with definiteness – only the betting odds can be given. Spontaneous *random* fluctuations in the structure of matter, and even of spacetime, inevitably occur.²³

- As a result of the wave-particle experiments in which the setup of the experiment determines the outcome and in which an objective measurement without interference is not possible (to detect a photon one in turn has to treat it with light, meaning photons, which diverts the photon of observation), the part of the observer is a crucial one:

The new facts about perception make it impossible for us to assume that there is any reality experienced by man into which man's own observations and interpretations do not enter. Thus the assumptions of naive realism – seeing the things as they really are, quite apart from our reactions to them – become impossible. Yet equally, the facts of perception in no way lead us to a late form of idealism; they do not require us to suppose that there is no kind of reality outside the human mind; they point rather to the insistence that all human experience is an interpretation of the non-human reality. But this, again, is not the duality of subject and object – the assumption on which almost all theories of art are based. We have to think, rather, of human experience as both objective and subjective, in one inseparable process.²⁴

Summarizing, the main principles can be described by the terms complementarity, indecidability, non-causality, anti-materialism and status of observer. Physics therefore is not scientific in its ideal form anymore: it infringes the principles of objective observation and the deduction of events from causal connections.

²³ Davies, Gribbin, p. 141-142.

²⁴ Strehle, *Fiction in the Quantum Universe*, 1992, p. 5.

With the beginning of new physics, one is confronted with realities that are neither plausible nor logical in an Aristotelian sense nor in any way comprehensible but still have been discovered. In order to understand these new insights we have to change our common sense. The Aristotelian principle that A cannot be valid with non-A at the same time, meaning thesis and antithesis are incompatible, does not apply to findings like the wave-particle duality. This is also true for our concept of time, revolutionized completely by the theory of relativity. Reality all of a sudden seems to be more fantastic than fantasy.²⁵

Here, the distinction between physics and metaphysics is getting difficult. Physics becomes a science of probabilities and not so much a science of facts. Terms like *materialist*, *rationalist* or even *realism* loose their meaning.

Susan Strehle introduces the term *actualism* for literary studies: actualistic literature is literature that is not making the distinction between realistic representation of reality and anti-realistic exploration of artistic processes. This is due to the fact that fixed points like time, space and reality, which defined realistic writing, are not absolute anymore. The term *actual* is based on a statement of Heisenberg, that on the subatomic level reality is not real, but dynamic, active. *Actual* emphasizes the quality of *acta* in opposition to *res*, the solid matter that cannot be identified easily, if position and velocity at the same time are not given. "With its roots not in things but in acts, relations and motions, actualism describes a literature that abandons the old mechanistic reality without losing interest in the external world."²⁶ Considering fiction, it is interesting that "to act" means "make" as well as "fake", two aspects that are complementarily true for any situation of narration.

Antecedents of actualistic literature are already Cervantes,

²⁵ For details, see Pauwels, Bergier, *The Morning of the Magicians*, 1968.

²⁶ Strehle, 1992, p. 14.

Sterne, Fielding and Diderot, because they create awareness for the problematic nature of representation and therefore establish an autoreflexive description of a reality that is not comprehensible in realistic terms.

The works described by Strehle (from authors like Thomas Pynchon, John Barth and John Fowles) are referential but non-mimetic. They subvert the conventions of realism without neglecting the demands of describing reality. Brian McHale in 1987 states very appropriately in his book *Postmodernist Fiction*: "...this imitation of reality is accomplished not so much at the level of its content,... as at the level of form."²⁷ The inspiration for writing experiments on a formal level is strongly influenced, deliberately or unconsciously, by the statements of modern science regarding form. The common ground for arts and reality are the new physical principles which are summarized by Strehle with the adjectives "discontinuous, statistical, energetic, relative, subjective, uncertain".

What does all this mean for literary analysis? What kind of transfer regarding thought experiments and analytical thinking can be carried out? If reality cannot exist independently from perception and observation, does a text exist without the perceiving and observing reader? On the subatomic level, there is no "natural normal state" – analogously, there is not *the* text per se – Of course this is known already through disciplines like reader-response criticism and aesthetics of reception, but here it is meant not only on the level of semantics but especially on a structural level, that is to say on the level of production, namely the operation of writing. Texts are written in a way that the reader has to intervene, because a decision for one route of lecture is demanded from him. Manipulation is a prerequisite of perception, even of reading, because reception here can be equated with the status of the observer in the experiment. If one reads, one also manipulates the text! The result is not

²⁷ Quote in Strehle, p. 19.

normative but subjectively minted. Texts do not have stabile states but are relative. Nonlinearity is therefore a potential text generator, as the presented works will show. Volatility and contradictions are a basic condition and not an error that has to be concealed or an inadvertent narrative incoherence. What Vanderbeke diagnoses for particle physics also is true for texts:

Im subatomaren Bereich ist es in verschiedener Hinsicht unmöglich, über Tatbestände eindeutige und widerspruchsfreie Aussagen zu treffen. Es ist vielmehr zur Beschreibung eines Systems notwendig, gegensätzliche Aussagen miteinander zu verbinden oder eher nebeneinander stehen zu lassen, um das System vollständig zu beschreiben.²⁸

With these words one could describe the anti-criminal novel *La Reprise* by Alain Robbe-Grillet (2001), where with two competing and mutually negating narrators, who also are placed in different parts of the text, namely main text and commentaries, this juxtaposition is typographically made clear in terms of content and in terms of form. There is no intermediating third part, no synthesis – which can be recorded not only with Robbe-Grillet but in general with new experimental novels as a writing method.

A crucial emphasis lies in the fact that science here can act as a model; science does not provide reality itself but merely a description of reality.²⁹ One common aspect of both literature (and literary

²⁸ Vanderbeke, p. 23. English translation (by SZ): “On the subatomic level, it is impossible in several respects to make definite and unambiguous statements about physical facts. Rather, it is necessary for the description of a system to combine conflicting statements with each other or just leave them both side by side in order to describe the system completely.”

²⁹ Vgl. Davies; Gribbin, p. 18: “At the heart of the scientific method is the construction of *theories*. Scientific theories are essentially models of the real world (or parts thereof), and a lot of the vocabulary of science concerns the models rather than the reality. For example, scientists often use the word ‘discovery’ to refer to some purely theoretical advance. Thus one often hears

studies) and natural sciences is the desire to make a statement about the world – as Niels Bohr stresses: “In der Physik geht es nicht darum, wie die Welt *ist*, sondern darum, was wir über die Welt *sagen* können.”³⁰ As a result, nature is subject to our way of examination;³¹ although, what is questioned is the possible rather than the factual. The object of investigation for literary descriptions as well as for scientific theories is the potential reality, not so much the factual one.

Three Attempts of Analysis

Three examples of literary works shall illustrate in what way novels or films can be described by models of particle physics. With chapter 34 from Julio Cortázar’s novel *Rayuela*, published in 1963, one can dare a kind of literary double slit experiment; Svend Åge Madsen’s novel *Days with Diam* from 1994 can be compared with the idea of superpositions and the many-world’s theory; Per Fly’s TV-series *Forestillinger* (Denmark 2007) explains the per se subjective perception of reality and the importance of the observer.

1. Cortázar and the Double Slit Experiment

On the basis of *Rayuela* one could dare various “literary-physical” experiments: Kirsten Mahlke, a scholar of hispanistic literature, has discovered for example that the initials of the characters in the novel coincide with chemical elements, represented by the same letters, and that their encounters evoke the same reactions that would

it said that Stephen Hawking ‘discovered’ that black holes are not black, but emit heat radiation. This statement refers solely to a mathematical investigation. Nobody has yet seen a black hole, much less detected any heat radiation from one.”

³⁰ In Davies; Gribbin, p. 27. English translation (SZ): “Physics is not about how the world *is* but what we can *say* about the world.”

³¹ See statements of Heisenberg, in Emter, p. 54.

be caused by mixing together the corresponding elements.³² Brownian motion³³, mentioned several times in the novel and a typical example of a random unpredictable process of motion, provides another possibility of investigation; one could show how not only the characters in the novel move and act in the Brownian way but also the reader who follows the “random” zigzag of the chapters as proposed by Cortázar as one variant of lecture in his introduction. But because of its outstanding two-lined structure – a text fragment out of a trivial novel is interwoven with the commentary of the narrator about the novel in a way that alternately every other line belongs to one of the two continuous texts – chapter 34 seems to be predestined for the double slit experiment.

How does the double slit experiment function and what does it tell us?

In 1817, Thomas Young provided conclusive proof that light exists in the form of waves. In 1926 the double slit experiment was for the first time carried out successfully with electrons by Germer and Davisson. The set-up of the experiment is one of the most significant ones of modern physics:

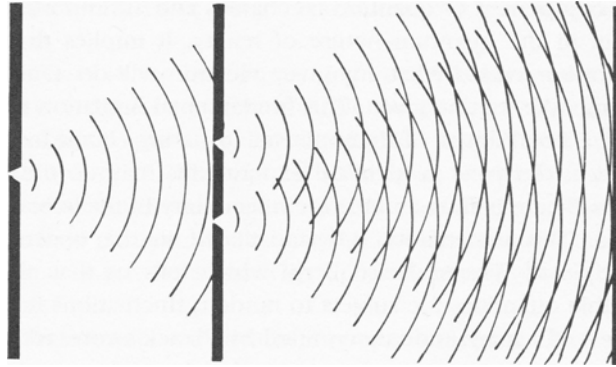
Bis heute hält dieses Experiment die Physiker in Atem, denn es hat im Lauf der Jahrhunderte in immer neuen Varianten dafür gesorgt, dass die Fachwelt aus dem Staunen nicht herauskam. Was haben Physiker nicht alles durch diese Spalte gejagt: Licht aller Wellenlängen, Schrotkugeln, Elektronen, Protonen, Bälle, Röntgenstrahlen. Sie haben die Detektoren verändert, verfeinert, bewegt, den Doppelspalt verschoben und bewegt, Messge-

³² For more details see chapter 5.3. “Magie, Alchemie und Quantenphysik in Rayuela” in Mahlke, *Schwebestände*, in print.

³³ The Brownian movement says: A tiny particle floating in fluid (or also a dust particle in the air) moves in a random zigzag under the microscope – as a consequence of the somehow dissimilar pushes by the fluid molecules who are bombarding it from all sides.

räte dazwischengestellt, und trotzdem sind die Ergebnisse dieses Experiments immer wieder verblüffend, und ihre Analyse gab den Forschern lange Zeit Rätsel auf. Noch heute denken Wissenschaftler auf der ganzen Welt über die Geheimnisse des Doppelspalts nach.³⁴

So, why not send text particles through the double slit? The original set-up of the physical experiment looks like this:³⁵

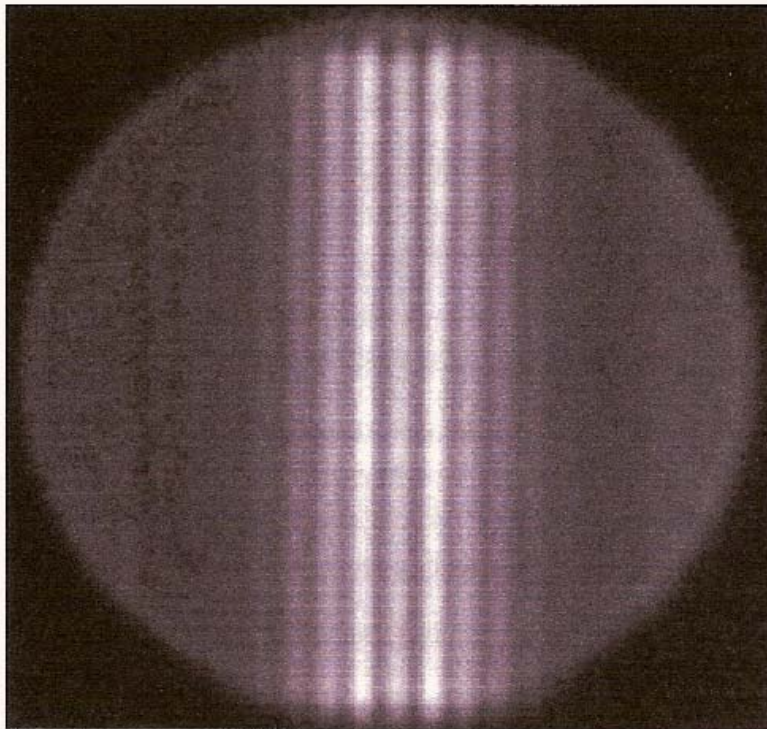


A partition plate with two small parallel slits separates a monochromatical light source on the one side from a screen on the other side. If only one slit is open, one can observe a light bar on the screen, exactly opposite the slit. If the other slit is open, too, it is

³⁴ Röhlein, *Die Quantenrevolution*, 2004, p. 20. English translation (by SZ): “Even today this experiment keeps physicists on their toes, because over centuries it has managed with ever new variations to keep experts gaping in astonishment. Physicists have sent all kinds of things through these slits: light of any wave length, pellets, electrons, protons, balls, x-rays. They have changed, refined and moved the detectors, relocated and moved the double slit, put measure instruments in between, and still, the results of this experiment again and again are just stunning and their analysis posed riddles for the researchers for a long time. Still today scientists all over the world reflect about the mysteries of the double slit.”

³⁵ Fig. in Davies, Gribbin, 1992, p. 210.

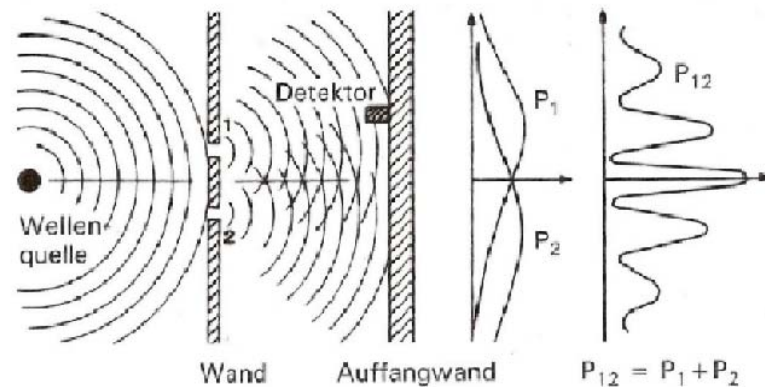
not two bars that can be seen, nor the sum of both, but a pattern of light and dark bars, with an intensity maximum on the axis of symmetry between the bars, as following image is illustrating:³⁶



This result is only explicable by the wave function. Like with a stone that is thrown into water, wave movements arise that interfere with each other: If a wave peak is hitting another wave peak, the wave is increased, (= constructive interference), is a wave trough meeting a wave peak, they annihilate each other (= destruc-

³⁶ Fig. on http://astro.uni-tuebingen.de/groups/opt_det/d_spalt.jpg.

tive interference):³⁷



The experiment gets more interesting, if the screen is substituted by a photo plate and the intensity of the light source is reduced to one photon per second. With one slit open, it produces an intensity maximum (bar) exactly opposite the slit. With both slits open at the same low intensity, light nevertheless behaves as a wave, like before, although the particles (photons) cover the way to the plate separately. In order to get a pattern of interference, a photon would have to interfere with itself, meaning it would have to go through both slits at the same time – a riddle for every Aristotelian mind: Is light a wave or a particle or both?

Es liegen zwei Verhaltensweisen und zwei dazugehörige Beschreibungsmodi vor, die sich gegenseitig ausschließen, die, will man sie auf eine einheitliche Sichtweise zurückführen, unweigerlich Paradoxien hervorrufen. Und dennoch gehören beide Verhaltensweisen von Photonen oder Elektronen zusammen, auch wenn dies der traditionellen physikalischen Anschauung und

³⁷ Fig. in Röhlein, 2004, p. 29.

unserer Alltagserfahrung vollkommen widerspricht. Das Doppelspaltexperiment weist ferner einen eigentümlichen Zusammenhang zwischen der Versuchsanordnung und dem beobachteten Ergebnis auf, da es anscheinend nicht gleichgültig ist, ob sich in der Trennwand ein oder zwei Schlitze befinden. [...] Es scheint gerade so, als mache das Elektron sein Verhalten von dem abhängig, was der Beobachter weiß. Solange man nicht beobachtet, durch welchen Spalt das Elektron (oder Photon) hindurchtritt, kann ihm keine feste Bahn zugeschrieben werden. Es scheint wellenhaft im Raum ausgedehnt zu sein und durch die beiden Spalte gleichzeitig hindurchzuziehen.³⁸

Let us look at the first lines of our literary text:

En setiembre del 80, pocos meses después del falle-
Y las cosas que lee, una novela, mal escrita, para colmo
cimimiento de mi padre, resolví apartarme de los negocios,
una edición infecta, uno se pregunta cómo puede intere-
cediéndolos a otra casa extractora de Jerez tan acreditada
sarle algo así. Pensar que se ha pasado horas enteras de-
como la mía; realicé los créditos que pude, arrendé los
vorando esta sopa fría y desabrida, tantas otras lecturas

³⁸ Emter, 1995, p. 47 and 48. English translation (by SZ): “We are dealing with two ways of behaviour and two corresponding modes of description that contradict each other and inevitably cause paradoxes if one wants to reduce them to a homogeneous point of view. And still, both ways of photons’ or electrons’ behaviour belong together, even if this totally contradicts the traditional physical notion and our daily experience. In addition, the double slit experiment exhibits a peculiar connection between the set-up of the experiment and the observed result, because it seems to be important if the partition plate has one or two slits. [...] It even seems that the electron acts depending on what the observer knows. As long as nobody observes through which slit the electron (or photon) passes, no determined route can be ascribed to it. It seems to be stretched out in space like a wave and passing through both slits simultaneously.”

predios, traspasé las bodegas y sus existencias, y me fui a increíbles, *Elle* y *France Soir*, los tristes magazines que le vivir a Madrid. Mi tío (primo carnal de mi padre), don prestaba Babs. *Y me fui a vivir a Madrid*, me imagino [...].³⁹

Treating these lines as we would normally do (namely reading them chronologically line by line), one cannot interpret those “text bars”, they make no sense. After only a few lines it is clear that no coherent line-serial course can be detected, and some lines later one discovers that we are dealing with two interwoven texts that do proceed continuously, but shifted line by line. One will fail miserably trying to read both texts at one time. If we close one of the two slits though, meaning one part of the text, and if we do so for each of the two parts, then two singular text bars are revealed that can be read coherently:

En setiembre del 80, pocos meses después del fallecimiento de mi padre, resolví apartarme de los negocios, cediéndolos a otra casa extractora de Jerez tan acreditada como la mía; realicé los créditos que pude, arrendé los predios, traspasé las bodegas y

³⁹ Cortázar, *Rayuela*, 1963, p. 255. English translation: “In September of 1880, a few months after the demise of my father, I decided to give up my business activities, transferring besides, but you wonder how she can get interested in things them to another house in Jerez whose standing was as solvent like this. To think that she’s spent hours on end reading tasteless as that of my own; I liquidated all the credits I could, rented out stuff like this and plenty of other incredible things, *Elle* and the properties, transferred my holding and inventories, and *France soir*, those sad magazines Babs lends her. *And moved to Madrid to take up residence there*, I can see how after you swallow four or five pages you get in the groove and can’t stop read- [...]” Cortázar, *Hopscotch*, 1987, p. 191.

sus existencias, y me fui a vivir a Madrid. Mi tío (primo carnal de mi padre), don [...]. [all odd lines from 1-11]

Y las cosas que lee, una novela, mal escrita, para colmo una edición infecta, uno se pregunta cómo puede interesarle algo así. Pensar que se ha pasado horas enteras devorando esta sopa fría y desabrida, tantas otras lecturas increíbles, *Elle y France Soir*, los tristes magazines que le prestaba Babs. *Y me fui a vivir a Madrid*, me imagino [...]. [all even lines from 2-12]

So far what we are dealing with is only the amalgamation of two singular text particles – if it was not for the interference pattern that emerges, like in the physicist's double slit experiments, as soon as both slits are open and the particles have the opportunity to interfere with each other. In the case of Cortázar, by no means can the two texts be put next to each other separately as if they never had passed the same partition plate – here meaning the same chapter. Inevitably, the text, like the photons or electrons in the experiment, is behaving like a wave: it builds up intensifications and annihilations, the so called constructive and destructive interferences.

We will not deal here in detail with the constellations of the characters, or aspects of the plot in the novel; only saying this much: the text part of the odd lines is from a novel that the female protagonist Maga has read once and that is found by her lover Horacio, narrating voice in this chapter; in the even lines this narrator Horacio is commenting on the – for him – low quality literature in the beginning, later in the chapter he addresses Maga directly and uses the excerpt for his reflection on their failing relationship.

So, initially one can detect the annihilating interferences, whenever the narrator is citing fragments out of the co-text in a mocking and criticizing manner, most often only one or two lines later in his text after the quoted text has appeared in the original novel. Here, text-‘waves’ are meeting each other and are annihilated through irony, the value of the first text is negated through the repetition in

the debasing commentary of the second text. Some examples, out of many – the parts in italics are also in italics in the novel and represent the literal quotations: “*Por fin supe hallar un término de conciliación, una lengua hecha de frases preacuinadas para transmitir ideas archipodridas*”⁴⁰; “*¿llorando a moco y baba?, pero es sencillamente asqueroso como expresión*”⁴¹; or “*y elegantos teatros. ¿De qué está hablando el tipo?*”⁴²

During the ongoing chapter, though, the narrator starts to let himself be inspired by the reading of the ‘trashy novel’ and incorporates fragments of sentences in his own text, not to mock or criticize them but to use them himself as expressions or as initiations for memories and thoughts, as in following examples: “*polvorosas plazuelas, está bien, pienso en las plazas de los pueblos de la provincia [...]*”⁴³ Finally, the commentary even takes over the previously so harshly deprecated language register and practices self-reflection: “*y deluir fatigosamente sus relatos, exactamnete esto, me pongo pesado hasta cuando hago memoria.*”⁴⁴ Here, the effect of the language-‘wave’ is intensified, the interference is a constructive one. In the end of chapter 34, the florid mode of expression of the novel fragment is interfering to such an extent with the otherwise ironizing and vulgar language of the protagonist, that he praises his beloved one in a most flowery, ornate style: “vos temblabas, pura y libre como una llama, como un río de mercurio, como el primer

⁴⁰ Cortázar, p. 255. Engl. transl.: “*I was finally able to effect a compromise, a style that uses prefabricated words, to transmit superannuated ideas*”, p. 191.

⁴¹ Cortázar, p. 261. Engl. transl.: “*weeping until his nose had begun to run?, but that’s really too repulsive*”, p. 195.

⁴² Cortázar, p. 257. Engl. transl.: “*elegant theaters. What the hell is the guy talking about?*”, p. 192.

⁴³ Cortázar, p. 257. Engl. transl.: “*dusty old squares, that’s all right, it reminds me of the squares in provincial towns*”, p. 192.

⁴⁴ Cortázar, p. 260. Engl. transl.: “*and his accounts would be lengthened to a tedious degree, that’s it exactly, I get boring even if I reminisce.*”, p. 195.

canto de un pájaro cuando rompe el alba [...].”⁴⁵

The decision of what and how one chooses to read, which of the two slits one opens or if one lets both parts interfere has a significant effect on the result. In each case one will get a different result from reading. Chapter 34 functions in this as an example for the whole novel that keeps on inserting intertexts in the form of additional chapters, leaving it to the reader, which or how many of the slits he or she wants to open, if he wants to jump to the connected supplementary chapters placed in the last part of the book or leave them out. One can read the parts of the book separately or in the interfering way, classically as particle, or as a wave.

Now, how can one use the application of the double slit experiment on literary texts in a more general way? Maybe it would be possible to illustrate the function of intertextuality: In which way do intertexts interact with each other, how do constructive and destructive interferences build up, where do texts reinforce or annihilate each other, but also, in what way does the intention of the observer play a part in this, does a text become different just by opening another slit? Finally, one could examine how texts interfere with themselves if one is sending them not only through one but through several slits, could one and the same text fragment function as one thing and at the same time as another?

2. Madsen and Superpositions

In Madsen’s novel *Days with Diam – or: Life at Night*, published in 1994, quantum physics is not explicitly a topic, yet it deals with thought experiments that are well known to us from physics and science. Schrödinger’s imaginary cat – who is both alive and dead at the same time in a box, as long as nobody verifies and therefore de-

⁴⁵ Cortázar, p. 261. Engl. transl.: “you used to tremble, pure and free as a flame, a stream of quicksilver, like the first notes of a bird when dawn is breaking”, p. 196.

termines the state by checking and opening the box – is the most famous world wide illustrative example for explaining superpositions. Schrödinger's equation after all is the starting point for the many-world's theory that dates back to the late fifties and assumes that in any moment of decision the universe parts into two universes which then coexist parallelly. Because this division takes place at any point of quantum interaction, the multiple realities are infinitely manifold – even if we, in the universe we perceive, don't realize it: "Taking the many-world's theory to its logical conclusion, we are led to suppose that countless times every second each human being is split into duplicate copies, each copy inhabiting a slightly different universe. Necessarily, each copy will only perceive *one* universe, and be aware of only *one* self."⁴⁶

Madsen used this concept for the structure of his novel. Departing from one chapter there are two variants how the story could go on. Each new chapter again produces two continuations. The table of contents looks like the illustration on the next page.⁴⁷

Comparable to a phylogenetic tree, each 'mother' chapter results in two offsprings, each branch bifurcates into two branches and so on. By the way, the metaphor of a tree is quite liked and often used by scientists in this context: "Sometimes the many-universes model is represented by the branches of a tree. The 'trunk' symbolizes a particular universe which we use as our reference point; this then branches and rebranches into all its quantum alternatives."⁴⁸

For reading the book *Days with Diam* this means that a decision of the reader becomes necessary at each point of bifurcation. But Madsen's spelling system makes it easy to go back to the starting point and choose the other route – in contrast to a rendered decision in reality. Therefore, orientation in the parallel versions is

⁴⁶ Davies, Gribbin, 1992, p. 228.

⁴⁷ Madsen, 1994, p. 5.

⁴⁸ Davies, Gribbin, 1992, p. 228.

given from the beginning, as Madsen's instructions for reading proof:

Contents

S 7	SA 12	SAL 18	SALA 33	SALAM 60	SALAMA 119
				SALAN 65	SALAMO 124
			SALME 69	SALAND 127	
		SALM 36	SALANE 130		
			SALMER 132		
			SALMET 138		
	SAN 21	SAND 41	SALMIE 142		
			SALMI 72	SALMIN 145	
			SANDA 75	SANDAL 148	
		SANG 44	SANDAT 151		
			SANDE 80	SANDEL 155	
			SANGES 167		
	STO 26	STOL 47	SANGUR 181		
			SANGU 87	SANGUD 175	
			SANGER 171		
STOR 50		STOLE 90	STOLEN 185		
		STOLI 94	STOLER 188		
		STOLIE 194			
STR 29	STRE 53	STOLID 191			
		STOREA 197			
		STORES 200			
	STRI 57	STORME 204			
		STORM 101	STORMML 207		
		STREG 105	STREG 211		
ST 15	STR 29	STREGL 216			
		STRENG 221			
		STRENO 224			
	STRID 112	STRIDE 228			
		STRIDT 232			
		STRIME 236			
STRIM 116	STRIML 240				

In order to make possible a general view, I have furnished the few sheets I have so far accumulated with various designations in the form of capital letters. By means of these it is possible out of my chaotic experiences to extract a series of events which with a little good will can be regarded as a completed story.

Thus the final section of each story will have six letters, for instance SALMIE. (The letters are chosen so that the different variants are relatively easy to keep apart. I have not aimed at making these letters 'mean' anything.) The story ending with the section designated as SALMIE can be read in its entirety by first reading section S, then SA, then SAL, then SALM, then SALMI, after which the section designated SALMIE will provide the conclusion of the story. So you spell your way through towards the end.

You can choose your path in many different ways. When you have read S, which in this case is the beginning of all things, you can spin a coin to decide which way to go. If it shows heads you take the first continuation, SA; if it shows tails you can move to the other, ST. And by tossing a coin five times in this way you can reach the final part of the 'short story'. Thus you will reach the aforementioned SALMIE if you throw heads at the first two tries, then tails for the next two and heads for the last.

But now I will give a brief set of instructions for those individuals who are not minded to submit themselves to the vagaries of chance.

Readers who like a straightforward love story will, it is to be hoped, derive pleasure from the stories beginning with the letters SAN. Of these, SANDAT is an example of a light-hearted story, while SANGEN is just a little melancholy.

The stories beginning with STRE, too, are about the main character's encounter with a young woman, although this encounter has a rather more complex background than the SAN variations. For instance STREGL is a bitter story taken from re-

ality. Those beginning with STRI will seem less realistic. As will be seen in curious STRIDE episode, they are distinguished by mystery and obscurity.

The ‘twin’ stories SALMER and SALMET have something essential to say about people’s ability to be together.

After some of the more immediately comprehensible stories have been read, some explanation of the real intention might be necessary. This will be found in each of the variations beginning with STOR. A rather more contrived explanation will be found in the STOL variants.⁴⁹

In an infinite number of possibilities, likely conditions occur as well as extremely improbable ones. From the happiest ending of the story to a very tragic end, all variants have their – at least potential – justifiability of existence. This patchwork of chapters seems like a collection of 32 short stories, as Madsen himself says, “a very special collection in which the individual stories are woven into each other, impinge on each other and contradict each other in the most sophisticated and tortuous ways.”⁵⁰ Still, one can call *Days with Diam* a novel, because the chapters are, in their specific order of spelling, chronologically combined as one (or rather several) linear plot(s). That several strings of plot coexist parallel and duplicate continuously doesn’t undermine the status of a novel, except that maybe a plural term would be more suitable: a multiple novel or a many-world’s novel. Instead of the currently used scientific term *many-histories-interpretation* one could introduce in analogy a *many-stories-interpretation* for literary studies.

The economy caused by Madsen’s choice of structure is remarkable, as he illustrates with some calculations: Assuming the number of 32 stories, each with 18 pages on average (6 chapters with 3 pages each), the text volume would mount up to 576 pages

⁴⁹ Madsen, 1994, *Days with Diam*, p. 50-52.

⁵⁰ Madsen, 1994, p. 50.

in total,⁵¹ if the beginning chapters were not identical with at least one other text that has been printed already. In case of the first chapter one can save 31 further copies by using the bifurcation method. Therefore, *Days with Diam* is an extremely compressed book.

In writing so many possible ways of his own story, the main character of the novel and narrator of all chapters discovers a potentiality of journeys through life which every human being who believes himself existing in a one and only valid universe can only dream about. The possibility for not having to choose but simply living both options is applicable already for trivialities of daily life:

I put myself in a situation where I have to choose: Do I want coffee or tea? And hey presto, I am two persons, I am one drinking coffee and one taking tea.

That opens the flood gates, for all possibilities, all the possibilities I have dreamt of. At last I can come to live fully and wholly, love all the lives I have had to renounce.⁵²

Only the knowledge of many existing variants brings about the freedom to live one of them fully without regretting a decision or suffering the feeling of having missed something. Determination becomes the enemy of life: “certainty was an evil”.⁵³ Although, this leads to moral consequences in social behaviour – as the main character in the novel has to diagnose, in accordance to philosophical and ethical objections that are raised against the many-world’s theory: “I can rape a girl. If, later, I am caught, I will simply say that it was not me, but another of my segregations who did it. I can safely go out and steal: if I am caught, what does it matter when I can simply go on living in all my other ramifications?”⁵⁴ *Days with Diam*

⁵¹ Madsen, 1994, p. 102.

⁵² Madsen, 1994, p. 94.

⁵³ Madsen, 1994, p. 97.

⁵⁴ Madsen, 1994, p. 94.

therefore not only illustrates a new world view by its content as well as by its structure in particular, but also evokes at the same time the newly asked question in terms of social policy about the responsibility for the single life of one's own and of all the others.

Closing the circle to modern physics of the 20th century, Madsen's main message is reality's principle of complementarity that seems to contradict Aristotelian logic:

The present book [...] contains several different stories, several different threads of action which, according to normal logic, can't all be correct. From this it can be deduced that, with his use of unusual forms, the author is trying to say that the world is not unambiguous, but self-contradictory and paradoxical.⁵⁵

3. Fly and the Status of the Observer

Forestillinger is a TV-series consisting of six episodes of 60 minutes each, which was first broadcasted in 2007 in Denmark. Totally against the well-known principle of series, *Forestillinger* does not build up its sequence from one part to the next on events that happened in the precedent part and therefore spin the thread of narration chronologically, it rather yields six different aspects of one and the same period of time. Six people who are involved in different ways in the events – rehearsals for a production of Shakespeare's *Venus and Adonis* at a Danish theatre –, report from their personal point of view the happenings that were relevant for them from the beginning of the first day of rehearsal until the evening of the opening night. These six persons are Jakob, the young main character of the Shakespeare play, whose perception is strongly influenced by his newly discovered love for Tanja; Tanja, the female counterpart of Jakob in the play, who finds herself between her long-standing and now breaking relationship with her life partner

⁵⁵ Madsen, 1994, p. 103.

Markos and the recent flirt with Jakob; Katrin, who during rehearsals has the job of a photographer, daughter of the director Marcos and his ex-wife Eva; Eva, the third main character of the play, suffering from cancer and in vain trying to establish some contact with her daughter Katrin, who for her part vehemently rejects her mother; Jens, producer and artistic director of the theatre, a long-standing and close friend of Markos and secretly in search for a new field of professional activity; Markos, the director, totally absorbed by his work and emotionally drawn between the two competing women Tanja and Eva. The enumeration makes clear how much the singular life stories of the mentioned persons are interwoven with each other and interfere inevitably.

All six variants tell about one and the same reality, but after the second episode it is already evident that this exact “one reality” does not exist, that there is only a collection of individual perceptions which seem to be the objective truth for each reporting person but de facto are subjective perceptions and therefore distortions of reality. With each further sequence of the series it becomes clearer that a single objective reality is not existent. Again and again the course of narration begins with the first day of rehearsals and ends with the opening performance, and yet it is a new story that is told every time, although with certain effects of recognition – more so as the series in its six parts progresses –, however each time so new that even the last episode of the same time period again on no account is the sum of the so far seen elements. Each further report shows the antecedent ones in a new light, makes new aspects apparent that were as yet unknown, and contextualizes the events differently. If one watches the first episode again after having seen all six, or if one changes the order of the six episodes arbitrarily – which on no account causes any problems of understanding –, one will regard the individually tinted story quite differently, thanks to the background knowledge from the other episodes.

Interestingly, some of the incidents seem to be central. They are

told congruently by all narrators; the subjective focus hardly changes – for example the event of the first social evening in the restaurant in the very beginning of rehearsals. Other common moments take place in each episode, but yet with very different valuations, sometimes with deviating dialogues and moods – as for example the fainting fit of Eva, the argument between Eva and Tanja, or the tensions between Tanja and Markos. Some incidents are reported merely by one person – like Jakob’s temporary decision to quit the job, or Jens’ interviews for a new job as theatre manager. The story of Jens is probably the one that overlaps the least, followed by the story of Katrin. On the contrary, the episodes of Tanja and Eva are totally intertwined with the other stories.

The innovative and therefore interesting factor with *Forestillinger* is not only the insight that reality merely is subjectively conceivable and narrating can never be neutral. The decisive point comes with anchoring this knowledge in the process of narration. We already mentioned the fundamental significance of the observer in the quantum physics experiment. Subjectivity in the era of new physics has a totally new status, it is not only a disturbing factor in the perception of reality but per se the prerequisite for reality – without observer there is no defined state:

In the prequantum era of physics, everyone assumed that the world “out there” existed in a well-defined state quite irrespective of whether, or how, it was observed. Admittedly the act of observation would intrude into that reality, for we cannot observe anything without interacting with it physically to some extent; yet it was always supposed that the interaction was purely incidental and could either be made arbitrarily small (at least in principle) or else be performed in a controlled way and so be taken precisely into account. But quantum physics presents a picture of reality in which observer and observed are inextricably interwoven in an intimate way. The effect of observation is absolutely fundamental to the reality that is revealed, and cannot

be either reduced or simply compensated for.”⁵⁶

Without an observing person there is no story. In *Forestlinger*, a neutral narrator who could report about all six characters does not exist. There is always a subjective perspective, the personal point of view is important. The result of the experiment is determined by the setting up of the experiment; in analogy to this, the story one gets is determined by the starting point of who is narrating. Even the deceiving idea of objectivity is undermined by the offering of several parallel versions of reality. This is a film project that in its consequence is standing out strikingly among all those TV series that still suggest a chronological and objectively existing reality.

It is important to say that the afore mentioned examples of literature and film are in no way rare specimen when it comes to the point of concordance between structural models of quantum physics and the construction of narrations. They do stand out in terms of their consequent and often unusual realization, but still join an ever growing amount of literary transfers of a 20th century world view, not only on the level of motifs but especially on the level of structure. One can only be curious to see upcoming new publications, which surely will not cease this development yet.

⁵⁶ Davies, Gribbin, 1992, p. 215.

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