

MIT Open Access Articles

Erwin Schrödinger's Poetry

The MIT Faculty has made this article openly available. **Please share** how this access benefits you. Your story matters.

Citation: Sofronieva, Tzveta. "Erwin Schrödinger's Poetry." *Science & Education* 23, no. 3 (March 10, 2013): 655–672.

As Published: <http://dx.doi.org/10.1007/s11191-013-9579-4>

Publisher: Springer Netherlands

Persistent URL: <http://hdl.handle.net/1721.1/103342>

Version: Author's final manuscript: final author's manuscript post peer review, without publisher's formatting or copy editing

Terms of Use: Article is made available in accordance with the publisher's policy and may be subject to US copyright law. Please refer to the publisher's site for terms of use.



Tzveta Sofronieva

Erwin Schrödinger's Poetry

Dr. Tzveta Sofronieva

8th Max Kade Writer in Residence
Foreign Languages and Literatures
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, MA 02139
U.S.A.

Büro Tzveta Sofronieva
Dahlemer Weg 100
D-14167 Berlin
Germany

Fax & Tel.: +49 30 84728305

info@tzveta-sofronieva.de
tzvetas@mit.edu

www.tzveta-sofronieva.de

Erwin Schrödinger's Poetry

Introduction

Erwin Schrödinger (Austria, 1887-1961) is one of the main figures in 20th century physics. He played also an important role in other major scientific discussions. His literary work, however, is rarely mentioned, although he is the author of poems, diaries, essays, literary translations, a dialogue and an autobiography. Schrödinger wrote poems in two languages, German and English, and his 1949 poetry collection is one of the many historical sources to be fully discovered. As in other cases of poetry related to science, his poetic work “should not be dismissed, neither from the history of literature nor from the history of science” (Partington 2012).

Schrödinger is most famous for the important wave equation named after him that gives the mathematical formulation of atomic dynamics and its application to atomic structure. The fundamental postulate of the quantum mechanics was presented in January 1926 in Schrödinger's article “*Quantisierung als Eigenwertproblem*” [Quantization as an Eigenvalue Problem] (Schrödinger 1926) and is considered one of the most important scientific achievements. Schrödinger was awarded the Nobel Prize in Physics, together with Paul Dirac, in 1933.

When one looks for connections between Schrödinger's scientific contributions and the world of poetry, it is easier to find poems about him and to feel the inspiration other poets found in his work in physics than to appreciate the fact that he was a poet himself. Indeed, it is easy to forget that Erwin Schrödinger was more than a genius figure in the history of physics. All the facts of his life, however, attest to a special personality far beyond his scientific contribution. A brief look at Schrödinger's bibliography brings up titles of books such as *Science and the Human Temperament* (1935), a selection of his popular German lectures and essays; *What is Life?* (1944), a lecture in Dublin in 1943; *Gedichte* (1949), a selection of his poems; *Nature and the Greeks* (1954); *Meine Weltansicht*, an autobiography and a testimony written in two parts (1925 and 1960). James Watson admits, in his book “The Double Helix”, the impact that Schrödinger's ideas had on his and Francis Crick's discovery of the structure of DNA (Watson 2001). The work of Schrödinger in biology, philosophy of science and various other areas of knowledge have been widely studied. Researchers from different scientific fields bridge the gap between aspects of Schrödinger's work and state that the paradigm change he initiated has had great consequences for the natural and social sciences, the humanities, and our present scientific world-view in general, and that this was certainly influenced by his precise language of a physicist (Götschl et al. 1992). Yet, the relationship between Schrödinger's other work and his work in literature has not yet been a focus of much research. Götschl points out that we often fail to acknowledge Schrödinger's work outside mathematics and physics because, on the one hand, this work was “a victim of the Nazi time” and on the other hand due to “our reluctance, and even inability to give up received views” (Götschl 1992).

A closer look at Schrödinger's work in literature raises several questions. Which role did poetry play in his life? What lies behind the lack of acknowledgment of Schrödinger as a poet? How was his poetry related to his work in science? Did the fact that Schrödinger was a bilingual poet have an impact on his ideas as a physicist? A closer look at his poems might reveal in to the ways in which the literary and scientific strategies and expression of an individual illuminate each other. Re-reading his poems could enrich our understanding of how one of the major scientific figures of the twentieth century perceived the world and himself. This paper argues that Schrödinger's poetry is an integral part of his world view and his intellectual heritage. It approaches his work in literature using insights from the history of science and literary studies, and draws on the literary preferences of a poet who is a physicist and a historian of science by training, corresponding to Evelyn Fox Keller's recommendation for "an empathic identification with the object" (Keller 1985).

The Scientist and the Poet: Some Perceptions of Schrödinger's Work

The scientific achievements of Erwin Schrödinger served as inspiration in literature. Pre- and post-text, poetic waves and poetic force in the work of Eliot, Yeats and Pound show how the modernists appropriated his ideas as part of their general search for the origins of poetry (Albright 2007). Duncan makes it abundantly clear that his poetics is intimately connected with Schrödinger's scientific work and suggests that the radical changes in poetry in the postmodern era lies in the understanding of the different picture of nature offered by quantum mechanics (Carter 1990). The well-known *Schrödinger's Cat* experiment, where a cat in a closed box either lived or died according to whether a quantum event occurred, provoked numerous verses (Callaghan 2000; Adams 1982). The paradox that both universes, one with a dead cat and one with a live one, seemed to exist in parallel until an observer opened the box, was introduced in his essay "The Present Situation in Quantum Mechanics" in 1935, to illustrate the absurdity of dealing with probabilities. It played a big role in fiction and is today, among others, the basis of the electronic literary magazine with the same name that presents the work of Marie Annharte Baker, a Canadian Native American poet, who invents many self-identities (Wikipedia). There is, however, no evidence that the poets who were inspired by Schrödinger and wrote about him knew that he was a poet himself.

Both in the history of science and in the field of literary studies, there is an unspoken assumption that Schrödinger's interest in poetic expression does not deserve the attention of researchers. The dominant view of him as a poet is that he was the author of confessional rather than literary qualitative love poems that are unrelated to his scientific ideas and were merely the hobby of a womanizer. True, Schrödinger had a very atypical marriage and love life when compared with the social norm of the time (a fact even mentioned in the article on him in Wikipedia). He had many love affairs and sexual escapades, some of them with teenagers, and he, indeed, wrote several love poems in order to impress his beloved. This fact has strongly shaped the perception of him as a poet. In his poems he also humorously confesses that fame had never been important to him but that the love of women was. Little has been published about his poems, and what has is largely confined to his biography, especially when it comes to his various love affairs, for example when shedding light on

Schrödinger's life in Dublin (Moore 1989). In the most recent biography of Schrödinger, the words "poetry" and "poems" are completely absent from the index. The author, when mentioning that Schrödinger wrote poetry, finds it necessary to add the judgment "badly" and not comment any further on this (Gribbin 2012).

Once it has stuck, a label is not easy to remove. Recently, a mathematician presented two anthologies of poetry related to mathematics and physics and for the first time featured Erwin Schrödinger in the company of Jorge Luis Borges, Federico García Lorca, Szymborska and other of the world's famous poetic voices (Schreiber 2008, 2012). Unfortunately, he does this within the perceptual frames discussed above. In the first book the name appears, as so often, only in a poem on Schrödinger's cat paradox by another poet (Erbefels 2008). In the second book the editor centers a chapter around love because—in his words—at first glance being a non-mathematical feeling it is in fact often associated with metaphors from mathematics and the natural sciences. Schrödinger's poem "Lohn" ["Reward"] is included in the second book precisely in the chapter titled "Nach Küssen gerechnet" ["Calculated with kisses"] (Schreiber 2012), whereas for example a poem like "Parabel" ["Parable/Parabola"] (Schrödinger 1949) would fit most of the other more scientific topics of the anthology.

At the end of the poem "Lohn" ["Reward"], Erwin Schrödinger praises the beauty of love higher than fame and achievement (Schrödinger 1949). Yet, the perception of him shaped by his love poems seems to be one of the main reasons that Schrödinger's poetic work is unacknowledged. By looking closely at his poetry I argue that Schrödinger's appreciation of love in all its aspects and the fact that he wrote confessional love poems cannot reduce his poetic heritage to this feature. As a poet Schrödinger questions the reality of our external world no less than in his other work. Every static is taken away and there is a semantic level related to his scientific ideas.

The fact that Schrödinger wrote in two languages most probably worked against his acceptance by German literary studies because bilingualism in poetry is considered proof of lesser quality in the German-speaking world. This argument found recently place even on the pages of the highly recognized weekly newspaper "Die Zeit", in relation to a poem by Yoko Tawada who works in German and Japanese (Greiner 2004). The prejudices and controversial attitudes towards exophonic and bilingual authors in German literature are critically discussed by researchers outside of Germany (Wright 2007, 2008). In this context, a natural scientist and an author of relatively small amount of poems in two languages could not attract much attention.

Another major point of resistance towards Schrödinger's poetry lies in the complicated relationship between artistic expression and scientific achievement. Artistic images related to science often seem suspicious because they do not belong to the scientific sphere of rationality, and thus are assumed to be simply popularizing the science (Renn 1998). Convincing scientists that poetry can contribute to their field of study is almost impossible (Schreiber 2012). Comparatively, literary imagination is not valued when looking at Schrödinger's work as a physicist, and its influence on his research has not been investigated. Elkana links Schrödinger to the uprooted poetic intuitive Austrian cosmopolites like Kafka when discussing Schrödinger as a historian of science, and points out the role of language in Schrödinger's world view—"whatever we know about the world, be this knowledge scientific

or prescientific, is mirrored solely in our sensations, perceptions, memories, and, of course our language” (Elkana 1992)—but he also does not include in his considerations Schrödinger’s poetry. I argue that Schrödinger’s literary imagination and his bilingualism are an integral part of his approach to reality and their role in his scientific work needs further research.

Poetry and History of Science: The Case of Erwin Schrödinger

Many protagonists of recent and not so recent scientific developments have had a strong interest in literature. Still, it is not unusual in the history of physics to consider literary imagination and sensitivity unimportant for the “real” work of a scientist. Galileo’s Dialogues inspired Schrödinger (Schrödinger 1952) as well as many poets, but there are doubts as to whether Galileo is such an excellent scientist despite his literary interest or because of it. Some authors, Olshinski, for example, claim that he could have achieved more if he had not spent time on beauty (Greiff 2001). He is blamed for not staying in the land of mathematical laws. Comparatively, Schrödinger’s poetry bears witness to the fact that the 20th-century physicist felt the pressure of a similar questioning. He was aware of criticism that he prefers to rhyme than to calculate, “*lieber als rechne reime*,” and in his poetry he rejected the scorn of others with clear words. In his poem “Lohn” [“Reward”] (Schrödinger 1949), Schrödinger writes that he does not want to hear how much he is blamed for spending a lot of his life daydreaming and writing poems instead of calculating. He feels that he needs the daydreaming and the poet’s sensitivity for his scientific work.

Poetic and scientific strategies can converge and mutually illuminate one another. Neither for Kepler nor for Galileo was science separate from literary expression, and for many scholars after them literature and the natural sciences were fundamentally connected, to name Goethe as the best known example. Goethe’s work is a beloved topic in the history of physics, but his scientific rather than his literary texts (Amrine et al. 1987). Goethe is rarely recognized as a physicist among poets and students of literature. The conventional point of view consists of the myth that science and literature are somehow at opposite ends of the cultural spectrum, the one creates facts and the other creates fiction. The narratives and metaphors in this pair merit the most attention, and its linguistic and philosophical aspects exude fascination (Otis 2002). For some authors, “science and literature not only cannot be ‘reconciled’ but also they must not be” (Kipperman 1986). For others there is no unbridgeable abyss between them, “their differences being [...] merely modes of expression” (Koch 1989). One of the stated aims of research in the field is to open up “the possibility of serious critique of science that is not merely sentimental or alarmist” (Levine 1987) and “to produce a new understanding of the nature of *literature* and of *language*, and ultimately of our culture” (Weininger 1989). Schaffer and Shapin argue that what came to be called modern science has material, social and literary technologies (Shapin et al 1985). Yet, little attention has been given to literary strategies in poetic works by scientists, Erwin Schrödinger included. Shimek discusses a non-linear model in the relationship between science and literature based on Foucault’s book “The Order of Things” (Foucault 1996), presupposing that many forms of cultural evolve contiguously, and the knowledge in different areas is gained side by side (Shimek 2001).

Comparisons have been made between scientific work of the quantum physicists and the literary work of poets who are not scientists, but there has not been much interest in the individual “side-by-side” work. In this context the poetic interest and work of protagonists of scientific developments, and the poems of Erwin Schrödinger, deserve more attention.

The questioning gesture is intrinsic for poetry, no less than it is important in science. The German word for poetry, “Dichtung”, has one of its origins in the word “dictation” (from the old German "tihtunge" "Diktat", “Gedicht” *ti[c]hten* and from the lat.”dictare”). Some authors are interested in the brain structures related to poetry and see its meter as necessary for memorizing information (Schrott 2012). The other nuance of the word recalls the meaning “condense, full of density” (“gedichtet, verdichtet, Dichte”). After the technological breakthrough of printing, the latter fits better than the meter when we consider ways of passing on knowledge. Today we can include increasingly complex knowledge into the same volume of words only through poetic density (Sofronieva 2012). In the German language the word for poem, “Gedicht,” was used as a nomenclature for “alles schriftlich Abgefasste” [anything put down in writing], as the word for heritage of knowledge and for creative writing (Wikipedia). Perhaps this was the reason that Erwin Schrödinger titled his 1949 poetry collection simply “Gedichte” [“Poems”]. He could not find a better title to express the common thread of these diverse poems and translations.

Being a poet was essential for Erwin Schrödinger. In an interview on January 11, 1931 in “The Observer”, he confesses that deep in his heart he had always wanted to be a poet, but turned towards a scientific education recognizing that poetry could not offer him a career: “I must not give the impression that science alone interested me. As a matter of fact my early desire was to be a poet”, as quoted in the foreword to his autobiography (Dick 2008). According to Schrödinger’s wish, on his grave in Alpbach in Austria, his famous equation of 1926 and a poem from 1942 stand next to each other. For him science and poetry were inseparable. What was poetic work so important to the scientist himself? In his poem “Amantibus Poetis”, Schrödinger clearly expresses his appreciation for poetry as the greatest inner ability of a person to gain proper understanding of the world, as the “*power which sets the awry right*” (Schrödinger, 1949).

Collections of poetry are rarely considered research sources in the history of physics. The poetry collection of Erwin Schrödinger is not included in the Library of the Max Planck Institute for the History of Science in Berlin (as well as poetry collections or essays by Yeats, Pound, Elliot or other poets strongly concerned with quantum theory). Similarly, Kepler’s *Mysterium cosmographicum* cannot be found in the library of the Physics Department of the Technical University in Berlin and perhaps one does not even need to talk about Kepler’s *Somnium*, which presents a detailed imaginative description of how the earth might look when viewed from the moon, and is considered the first serious scientific treatise on lunar astronomy as well as the first work of science fiction (Sagan 2011). The contexts of science are simply outsourced; they are not considered to be an inherited reservoir of ideas (Greiff 2001). At the same time, awareness of context is an important issue for the founders of quantum mechanics. Max Born talks in his Nobel Lecture about mode of thought (Born, 1954) and in a discussion with Schrödinger talks about a style of thinking in physics quoting Pauli in a letter to him (Born, 1954). Schrödinger uses the notion of “cultural background” (Schrödinger 1952). He sees physics as part of culture in its entirety and thinks of the latter as

an integral expression of the different forms of culture. In his view, it does not influence science directly, but via the cultural background which consists of the deepest layers of human experience (Apostolova 1990).

Schrödinger had an excellent education in the humanities and retained his interest in literature and in languages throughout his life. His work has been broad and multilingual. He translated Homer from the original into English, translated French Provençal poets into German, given lectures in Spanish, cited the old Greek philosophers in his lectures in theoretical physics, and more. Historians of science have been interested in the part played by the translation of scientific texts in the globalization of knowledge but bilingualism and exophony have rarely been a topic in the history of science. Comments on the translation of texts in the history of science show the understated role of bilingualism and exophony or linguistic marginalism for the core of theory. In the preface of “Genesis and the development of a scientific fact” by Ludwik Fleck (Fleck 1979) for example, the editors admit that the translation of this German text written by a Jewish scholar from Poland and published in Switzerland was a very difficult task and a unique challenge because Fleck has introduced some terms that were not standard German usage, such as “Denkkollektiv” or “Sinn-Sehen” and confess that they have reworked the terminology avoiding the “the complex and often idiosyncratic original work” (Trenn 1979). These words, however, belong to a literary strategy of the author and could easily be related to the adopted and marginal usage of Fleck’s German.

Marginality is a one of the clue words when we look at Erwin Schrödinger as a poet not only because of the linguistic aspect. The broad interests of the physicist lead V.V. Raman and Paul Forman to a comparison with De Broglie (Forman et al. 1969), who studied history before becoming a physicist. He is considered a loner in the community of the creators of quantum mechanics. His role in the Einstein-Bohr debate on the interpretation of quantum mechanics was in-between (Röseberg 1992). As a physicist he is marginal because he does not belong to any school of contemporary physics. Schrödinger begins his article “Are There Quantum Jumps?” with a citation from Galileo’s Dialogue on the Two Greatest World Systems, 2nd Day. He quotes only the second part of Sartego’s sentence, pointing to his own situation in the scientific community 26 years after the publication of his equation (Schrödinger 1952). Erwin Schrödinger is marginal in poetry as well. He did not move within a particular literary circle. His verses were barely known by his fellow poets and are not much known today. The problem of marginality is a very interesting one because it shows the contradiction in the perception Erwin Schrödinger had of his self. Schrödinger was concerned with whether the culture of the 20th century would be marginal in 2000 years or as important as Ancient Greek culture is for us today. He felt that he belonged to a 2000 year old tradition and thus did not perceive himself as marginal in the history of culture (Apostolova 1990). In his poetry Erwin Schrödinger expresses this controversial perception of his role in the history of culture as well. On one side he feels attacked by his contemporaries, as written in the poem “Lohn” [“Reward”], and on the other side he believes that his work will live after him as in the poem “Glühende Asche” [“Glowing ashes”] (Schrödinger 1949). The relationship between a broad culture and social marginality are important for Schrödinger when he discusses the problem of causality (Forman 1971). A broad cultural background and social marginality allow a scientist, and a poet, to be free from the ideas of a particular scientific

community, or poetic tradition, and at the same time to be shaped by the development of the culture as a whole. This problem of freedom and determination was discussed by Schrödinger in several of his articles (Apostolova 1990) and is recognisable in his poems “Schwäne” [“Swans”] and “Parabel” [“Parable/Parabola”] (Schrödinger 1949) as well. For Schrödinger morality also had a meaning in history, and with an awareness of this he lived as freely as possible both privately and professionally (Apostolova 1990). The number of self-oscillations — or the ability to be sensitive to feel and create — depends on the freedom we allow ourselves to experience and corresponds to the number of the degrees of freedom we have (Irretier 2001).

The Expression of Love in the Work of Erwin Schrödinger

More than half of Erwin Schrödinger’s poetry consists of love poems and the dominant perception of him as a poet is based on these. Thus, any move towards a new perception of Schrödinger’s poetic legacy cannot avoid this part of his poetic work. Many of his love poems are light, funny and joyful. This style is not surprising, when one considers how much inspiration the young Erwin Schrödinger found in Franz Grillparzer’s erotic verses dramas. The confessional love poems are often sound romantic, but the author does not idealize the beloved one (Moore, 1989).

Schrödinger found love essential for a person and also essential in poetry. In his poem “Amantibus Poetis” he praises the love of the poets who save us from the unknown and from confusion and fear. In the eyes of his lyrical narrator, we are often torn apart by the fact that we do not know how we came to this life. Science cannot help us. It is poetry which lets us recover through love. The author believes that the love the poets wrote about, and the passion they wrote with, has a healing effect on a person, helping him/her to overcome pain and confusion.

Love is an important notion for Schrödinger not only in the artistic or erotic sense. In his journal, as cited by Moore in his biography of Schrödinger, after seeing a performance of Shaw’s play “Arms and the Man”, Schrödinger wrote: “All great things in the world are worked through love – not only children. It produces everything. Love is not an impediment to a great effort but its career” (Moore 1989). The biographer argues that the fire of Schrödinger’s genius could have been kindled by the tension which arose from the desperate situation created by the old quantum theory of Planck, Einstein and Bohr; his way of life, including the stress of personal relations and love affairs, was probably supportive of his creativity; and through his extensive diaries he obviously wanted us to know that a theoretical physicist need not be a man without qualities or passions (Moore, 1989). Leinfellner and Götschl point out that addressing the Prussian Academy of Sciences in 1922, Schrödinger stressed that his ideas were “obtained from a lifelong love of science” similar “as Pythagoras called himself a lover of wisdom” (Götschl et al.1992). Schrödinger sees love as a passion to unveil. In one of his love poems, “Kostümball” [“Costume Ball”], he plays with repetitions, melody and grammar to express a deep appreciation of the constantly changing nature of the world. In one of the lines, when talking about a kiss, he places a word whose usage is not associated with the rest of the verse or the topic of the poem. “Senkrecht” means vertical,

upright, perpendicular. When one reads the poem and recalls the poet's background in physics and his confession that his ideas are "obtained by a lifelong love of science", the question arises as to whether the beloved one in this poem is really a woman. She could easily be nature, science, poetry or the world. All four, nature [Natur], poetry [Lyrik], the world [Welt] and science [Wissenschaft], have a female gender in the German language. In the poem Schrödinger only talks about a "she" and does not mention, as he does in other love poems, a beautiful lady, a woman, a female dialogue partner or something similar. "She always was, she always is, tormented by the problem of the external and the internal", writes Gertrude Stein, referring to a particular person, to herself as a poet and to poetry as such (Stein 1933).

In the first line of the poem "Kostümball" ["Costume Ball"], there is only a hint, a sound, a seductive laugh, all from behind a white veil. In the second part there comes a kiss through the veil; and in the end a slight opening of the veil and an upright kiss, which the lyrical narrator wants to remember forever. In the mind of a personality like Schrödinger, who devoted himself to such different topics and activities yet to similar ideas, the integral image of a beloved woman is not so dissimilar to poetry, nature, science and the world. For Stein, poetry neither describes the external world "as it is" nor some essential "human" experience, neither the external world nor the world within, but rather creates a new reality (Shimek 2001). For the poet Schrödinger we investigate the reality through a veil and very rarely see through it. In another love poem, "An" ["To"], dreams and happiness speak through a person's eyes, but eyes can also kill, can make dependent, can cause loneliness. This, like several of his other poems, includes contradictions and contrasts, as well as veils, shroud, fog, and haze, thus expressing that things always have at least two meanings and they cannot be fully understood or experienced. The hesitation of reality is considered by Duncan, together with imagery and rhythm, as the subject matter of poems (Duncan 1973). And one can see things clearly, as expressed by Schrödinger in his poem "Amantibus poetis", by the virtue of love. .

Max Born writes about his friend Erwin's motives in science in the following manner: "I quite understand his triumph when he succeeded in interpreting those horrible stationary states as innocuous proper vibrations and the mysterious quantum numbers as the analogy to the numbers of musical overtones. He was in love with this idea" (Born 1953). Born was critical of some of Schrödinger's scientific positions but he respected the passion behind them.

Schrödinger's 1949 Poetry Collection "Gedichte"

Schrödinger's poetry collection was published in 1949 by Helmut Küpper, previously Georg Bondi, in Bad Godesberg, Bonn, Germany. There is no explanation for why Schrödinger published his poetry collection in this publishing house. A couple of facts could shed some light on his choice and perhaps also on his poetry. Helmut Küpper focused on poetry, Greek philosophy, and intellectual heritage as well as on educational topics (Flitner 1949). In poetry publications he continued the work of Georg Bondi who had been the publisher of Stefan George and his circle of poets. A closer look at Schrödinger's poems shows a connection to the early work of Stefan George (1958). George writes in a very self-reflective style, with

appreciation for nature, combining deep symbolic and impressionistic imagery; his poems are characterized as “nackte Substanz, schäumendes Gefühl” [“naked substance, vivid feeling”] (Benn 2003). None of these features are foreign to Schrödinger’s poems.

The collection includes 34 poems, 27 in German and 7 in English, as well as 6 translations from English into German of poems by different authors. Schrödinger has chosen to start the translation section of his book with a translation of the poem “To his Heart, bidding it have no Fear” by W.B. Yeats. The first lines of this poem speak as if from the heart of Erwin Schrödinger: “*Be you still, be you still, trembling heart; / Remember the wisdom out of the old days*” (Yeats 1958). There is no direct evidence that Schrödinger and Yeats knew each personally but it is obvious that they appreciated one another and were engaged with each other’s work (Schrödinger 1949; Albright 1997). Comparative research on the two poets may bring a new perspective to the relationship between quantum theory and modern poetry. In any case T. S. Eliot’s words about Yeats are very true for both of them: they belong to “those few whose history is the history of their own time, who are part of the consciousness of an age which cannot be understood without them” (Eliot 2004).

The publication of his poetry collection does not include any reflections of the author or the publisher on why these poems were chosen for the book; there is no introduction or afterword, no notes on the two languages in which the poems were written or why translations were included. First, the poems written in German are presented, then a page says: “In Englischer Sprache” and is followed by poems written in English, and then “Aus dem Englischen” announces the translations. Nothing else: the poetry itself is the only source the book offers.

The author did not include all his poems in this collection. He left out poems in both languages, as for example the poem “Zittern” [“Trembling”], which is cited in one of his biographies (Moore 1989) as well as some untitled poems written in German, such as “warum verstummt die fülle der gesichte?” [“why does the richness of history become silent?”], which remained unpublished. Schrödinger titled some of his poems differently in the book publication of 1949 from when they were written – for example, he renamed the poem “Sommer Sonnet” [“Summer Sonnet”] as “Juni” [“June”] (Schrödinger 1945, 1949). In general he did not make significant changes in his poems when he submitted the collection for publication.

There is no second edition of this collection and it was the only book of poetry that Schrödinger published. It had only an Italian translation included in an edition together with his biographical texts (Schrödinger 1987).

Erwin Schrödinger uses predominantly alternate rhyme and embracing rhyme. The images are related to a beloved one or to nature and memory. There are only few mathematical or physical metaphors. The style belongs to the romantic Romantic-Symbolist tradition which dominated the literature of the early twentieth century but in some poems. Some authors in fact call the quantum mechanics a Romantic physics (Plotinsky, 2004). In many poems though, Schrödinger’s imaginary goes hand in hand with a poetic indeterminacy (Perloff 1981), which became important in arts and poetry parallel to the development of quantum physics. Numerous German poems in Schrödinger’s poetry collection are written “[M]it einer ihm eigenen klaren, manchmal ironischen Knappheit” [“with a typical for him

clear, often ironic scarcity”] (Dick 2008) in a similar fashion to his autobiography. This style is typical also for his war journals (Schrödinger 1915).

Schrödinger’s Literary Work in Relation to his Scientific and Philosophical Ideas

Schrödinger’s poetry collection “Gedichte” [“Poems”] (Schrödinger 1949) includes several poems written in German that are not directly related to particular facts of his life and are not love poems. Perhaps it is natural that the biographies did not make much of them. However, these poems are the ones that show a relationship between his scientific ideas and his work as a poet and that therefore merit closer reading.

The poem “Parabel” [“Parable/Parabola”] examines life and order, and exemplifies Schrödinger’s understanding of the relationship between the laws of nature and scientists’ attempts to grasp them. The author addresses the reader directly, pointing out that everything we do, feel, and think, is pure coincidence resulting from our attempt to understand our world, and is due to random molecular movements. This poem corresponds to Schrödinger’s ideas in his lectures at Trinity College, Dublin, in February 1943, which were devoted to the physical aspects of the living cell and published a year later (Schrödinger 1944). In these he states that life greatly depends on order and that a naive physicist may assume that the master code of a living organism has to consist of a large number of atoms, and he elaborates that, on the contrary, the carrier of hereditary information has to be both small in size and permanent in time. He calls it aperiodic crystal and believes it to be the molecules whose stability could not be explained by classical physics, but which is due to the discrete nature of quantum mechanics. These ideas were the inspiration for the DNA discovery in science (Watson 2001) and for the aperiodic understanding of poetry (Carter 1990). The German title of the poem suggests a moral lesson and a comment that indirectly conveys a meaning by the use of comparison, and it includes both the language of physics and of literature, since the word in German carries both the meanings of parable and parabola. The author of the poem argues that neither “*lichtflecks irres zittern*” [“the confused shivering of a light spot”] nor “*dein jubeln und erbeben*” [“a person’s rejoicing and shuddering”] give us knowledge or satisfaction. It is rather the cultural context and the state of human development that is important for the success of our attempts to understand our world. This corresponds to his essays reflecting on scientific development (Apostolova 1990). “*Erst der Weltgeist, wenn er drangeht, / mag aus tausenden versuchen / schließlich ein ergebnis buchen*” [“*Only the world spirit when it begins to be concerned with / can out of thousand experiments / reach a result at the end*”].

Life seems to the poet to be too short to become deeply involved in the movements of the “weltgeist”. In the last line of the poem the lyrical narrator questions: “*Ob das freilich uns noch angeht?*” [“*Admittedly, is this at all our concern?*”]. The poet reflects here on our role in history of culture, as in another poem, “Glühende Asche” [“Glowing ashes”].

In “Glühende Asche” [“Glowing ashes”] the poet examines realities of which we are only half aware. These barely relate to us. They are so far away, so strange, foreign and incomprehensible that they almost bother us. Schrödinger has written on the mystery of human consciousness and philosophical determinism in relation to the ideas of quantum

mechanics (Schrödinger, 1944). He was sympathetic to the Hindu belief of a unitary consciousness pervading the universe. In this poem he denies any religious idea. All gods seem ridiculous, “*zum spott*” [“object of derision”], when we are confronted with death. “*Glaubst du an götter, oder glaubst du an Gott:/ ruf sie, ruf ihm, sonst warden sie zum spott.*” [“If you believe in gods, or if you believe in God: / call them, shout at him, otherwise they become an object of derision”]. The poet believes in life itself, in life which is “*bestenfalls mit schnellem tod belohnt*” [“in the best case rewarded with a quick death”], and he believes in the ability of human culture to remember and to recover: “*Ich glaub an lebende aschen in der glut*” [“I believe in glowing ashes in the embers”]. And this belief alleviates for the lyrical narrator any admiration or jealousy or competition because he believes that his work will live after him. The awareness of the fragility of life is woven through this poem. And Schrödinger’s belief in cultural heritage corresponds to his philosophical and scientific texts. As mentioned above, this poem and the poem “Lohn” [“Reward”] together with his “An Unpublished Dialogue of Galileo” (Schrödinger 1955) also mirror Erwin Schrödinger’s controversial perception of his own work as both marginal and essential.

In the poem “Schwäne” [“Swans”] a group of swans fly away in the dusk towards a place that is out of sight of a lyrical narrator, tired at the end of the day. There is interplay between observer and object, between image and discernment: When he looks at the swans, he does not know where they are flying to or how fast they are flying. Unlike a classical description of a physical system, the wave function does not give us definite information about the location of a particle at a given time; matter is time-dependent and dynamic. In the quantum mechanics, if one knows the position of the object one cannot know its speed of movement because the measurement changes the object. Schrödinger argued against uncertainty and probability with his cat paradox. Using the image of the swans in this poem he is reflecting on if observation changes the image. The glance of the observer influences the flight of the swans, although they do not know that they are being observed, and the swans’ flight cannot be predicted. The disappearing majestic birds represent his friends, following a longing for freedom of movement and to know what is coming. The dynamic of the metaphor of the swans questions the ability of the lyrical narrator to retrieve facts or to understand movement. As in some of his other poems Schrödinger ends the poem with a rhetorical question: „*so siehst du freund um freund hinter dem grat verschwinden / immer der sonne zu; wirst du sie wiederfinden?*“ [“and you see friend after friend disappear behind the ridge / always towards the sun; will you ever find them again?”].

The poem “Schatten” [“Shadows”] is one of the most interesting literary works by the author. Shadows are related to darkness but are not as abstract as the darkness since they have rims, clear borders between the dark and the light, and they are related to a body. A shadow is often a metaphor for the soul of the person; and in this poem the shadows act like people, like their twins. The shadows in the poem are “*eiligfliehend*” [“fleeing in a hurry”] and the lyrical narrator assumes that they are afraid of someone infringing upon their world. Maybe they do not move at all, and only the lime lamp which found them moves. The poet is interested in the shadow as an image for both contrasts and doubling. The shadows of Plato’s cave await the reader in this poem. The lyrical narrator is wondering if ideas can be captured, looked through. Or maybe these ideas are just a longing for knowledge which can never be obtained, because the ideas are just a construct without nature behind them. The link to the scientific

experience is offered by the description of the observer who studies the shadows. The innocent, coquettish and empathetic observer looks into the dark obscure hole —“*der ahnungslos kokette tiefmitfühlende beschauer nachblickt in das finstere loch*“. He is naively playing, without realizing how much he is pretending. The shadows mirror the interplay between the light, the body and the observer. A shadow dies in the night and a shadow cannot be captured by anyone, one can see it but cannot purely understand what it is. The end of the poem expresses, humorously, the sadness of the lyrical narrator due to his inability to fully understand nature: “*sein schnupftuch preßt in trauer*” [“*huddles his handkerchief in mourning*”].

The poem “Zürich”, which is rich in imagination, brings the reader to “*ruhigem genügen*” [“*a peaceful satisfaction*”], when all wishes coalesce in the wide silent space bordering a dream. The poem begins on the lake with a scene painted in a few words: “*Wenn auf dem see die sonne brütend ruht/.../die wellen leise auf und nieder wiegen*” [“*when the sun relaxes broiling and brooding on the lake/ [...] / the waves silently scale and sway to and fro*”]. The translation must use two words if it wants to retain the ambiguity of the German words used in these lines: “brütend” means “brooding” when it comes to ideas; and “broiling” if it is the sun. The verb “wiegen” means “to scale” if measuring is implied and “to sway” if it refers to water or a boat. The lyrical narrator standing on the shore of the lake in the poem feels secure, “*wohlig*” [“*blissfully*”]. „*Die stunde steht und alle wünsche schweigen*“ [“*The hour is still and all wishes are silent*”]. The described sensual experience of the lyrical narrator lets us feel the warmth, hear the water, makes us dream his vision together with the author. The images are beautiful and unpretentious, undemanding almost until the end of the poem. There though, when the participation of the reader is requested, the peace eschews the yearning: “*Doch öffnest du das aug zu fernen grenzen: / [...] / aus nebelchleiern steigt ein weißer traum, / der reinen firne überirdisch glänzen*” [“*Yet when you open your eyes towards far away boundaries/ a white dream stands up from the veils of the fog/ of the old fining supernal shines*”]. The reader is reminded of his own dreams and of another, familiar shore in his memory. Reader and author construct the reality of the poem together. The reader needs to find all elements of the poem in his experience in order to create a new meaning for himself through the poem, so the poem depends on the reader in the way reality depends on measurement. According to Dilthey, knowledge depends on lived experience and poets are gifted to feel this more intensively and to transform this experience by means of imagination (Azzouni 2007). In Schrödinger’s poetry this aspect mirrors the deep involvement of the author with the discussions on the interpretation of quantum mechanics. Schrödinger’s literary dialogue on the nature of light “An Unpublished Dialogue of Galileo” (Schrödinger 1955) also echoes these discussions.

In another poem, “Geborgen” [“Secure”], the lyrical narrator looks for security, for comfort, and he finds it in a place where the clouds sunbathe in the wind and the sun spots creep and grow and climb higher, and where one can forget more easily than anywhere else. Memory and forgetting, curiosity and envy entwine in this nature and love poem which at first reading sounds in the Romantic-Symbolist tradition that dominated the early twentieth century. In a close reading a poetic indeterminacy can be recognized: the poem seems not to embody uncertainty, hence is challenging clarity. In a similar fashion to the other poems, the author is true to his own thoughts as a scientist: “*Es ist ein Unterschied zwischen einer*

verwackelten oder einer unscharf eingestellten Photographie und einer Aufnahme von Wolken und Nebelschwaden” [“*There is a difference between a shaky or out-of-focus photograph and a snapshot of clouds and fog banks*”] (Schrödinger 1935).

Bilingualism and the Work of Erwin Schrödinger

Erwin Schrödinger learned two mother tongues, English and German simultaneously, at a early age in his Austrian family, due to the fact that both were spoken in the household. His great-grandmother on his mother’s side was English and one of his aunts in Vienna only spoke English to him. He spent long holidays in Leamington Spa, where his great-grandmother lived, as well as in Kenilworth and Warwick castles and Ramsgate. In his Austrian high school he became well acquainted with the works of Homer and Ovid, Goethe and Schiller. His interest in languages and poetry, in philosophy and in mathematics and physics developed simultaneously. Later, as cited by Moore, he wrote about his time at the Gymnasium: “*I was a good student in all subjects, loved mathematics and physics, but also the strict logic of the ancient grammars, hated only memorization of incidental dates and facts. Of the German poets, I loved especially the dramatists, but hated the pedantic dissection of their works*” (Moore 1989). Throughout his life Schrödinger retained his early passion for theatre, poetry and philosophy alongside his passion for science. He had friends among writers and artists. As a young man in Jena in 1920 he came to know Rudolf Eucken, a Nobel Laureate in Literature. In the second part of his life intensified his friendship with the Austrian expressionist playwright poet Franz Theodor Csokor. German and English continued to exist simultaneously in his life not only due to his contributions to international scientific discourse but also for political and personal reasons. From 1939 to 1955 he predominantly lived in an English-speaking environment. He was married to an Austrian but had several love affairs with Irish women. He became a naturalized Irish citizen in 1948, but retained his Austrian citizenship. His occupation with languages continued, as already mentioned he translated Homer from the original into English and old Provençal and English poems into German, and gave lectures in Spanish.

The natural early bilingualism, or exophonic experience, which shows up later in both his scientific and his poetic works, characterizes his thinking from the very beginning. At the age of four he commented: “*This says Mama, and this says Aunt. They are both only people. They could as well just say the opposite*” (Moore 1989). If a child feels two expressions of the same thing to be purely natural, it is perhaps easier for him to later feel the corpuscular-wave dualism to be natural. This was supported by Schrödinger’s the marriage of rationalism and traditional humanism in Vienna in his youth and of his later interests (Elkana 1992). He was an early admirer of Schopenhauer: “the world extended in space and time is but our representation” (Schrödinger 1967). He was also fond of Eastern holistic ideas and compared the two hemispheres of the human brain with the Chinese Yin and Yang, the logical and the intuitive which compete and intertwine. Schrödinger’s bilingualism may be seen in his use of both the language of poetry and the language of mathematics. By re-reading his collection of poetry from this perspective it seems not a pure coincidence that his poem about waves was titled “Zürich”, the name of the city where Schrödinger lived between 1921 and early 1926. In

1926 his fundamental papers on wave mechanics appeared along with the Schrödinger-Equation.

Schrödinger's wave function is a fundamental postulate of quantum mechanics and is the source of difficulties in the interpretations of quantum mechanics that continue to be debated today. In professional journals, personal letters and popular essays, Erwin Schrödinger and his fellow physicists were involved in an ongoing debate about the nature of quantum mechanics, looking for a language to discuss the new theory, and addressing the essential link between language and reality. "The real problem behind controversies was the fact that no languages existed in which one could speak consistently about the new situation", writes Heisenberg in "Physics and Philosophy" (Heisenberg, 1958). This search for a new language can be interpreted as an exophonic search: when adopting a new language we gain a linguistic self-awareness and are cured of linguistic narcissism—from being caught in the words and linguistic structures of the old native tongue that brings limitations in understanding time, space and more—, and adjust to a wider universe (Whorf 1956). Quantum physicists surprisingly often speak of the need for poetic power. "We must explain that, when it comes to atoms, language can be used only as in poetry. The poet, too, is not nearly so concerned with describing facts as with creating images and establishing mental connections", writes Bohr, as quoted by Heisenberg in "Physics and Beyond" (Heisenberg 1971). Science "means unrelenting endeavor and continually progressing development toward an aim which poetic intuition may apprehend, but which the intellect can never fully grasp" (Plank, 1936). Physicists needed to write philosophical-popular essays, self-reflective, often poetic lines, in which they often dwelled on a word, searched for a long time for a notion, often appealed more to emotion than to logic. They could talk about things they had no other way to express: projects, ideas and results regarding given phenomena that are fully admissible in one literary strategy and one genre are frequently unacceptable in another. "Each category thus corresponds to a cognitive niche, and thoughts can be legitimately expressed in one that defies the standards of certain others (Shinn et al 1985). Schrödinger's poetic work finds its natural place in this legacy of the creators of the quantum mechanics.

Schrödinger is interested in description, expression and change of meaning, he reflects on "Sprache und Begriffe" ["language and notions"] (Schrödinger 2012). In correspondence with Max Born he points out the difficulties related to notion extension and the necessity to make proper decisions for terminology of new concepts (Schrödinger, 1953). He also writes that when he feels attacked, as a physicist, for being at once very revolutionary and very reactionary, he would rather call himself simply "vernünftig", the word meaning both "sensible" and "reasonable". "*Für mich ist es besonders unterhaltend, wie Eure Kritik mich bald von rechts, bald von links anfällt. Auf der einen Seite bin ich ein wilder Revolutionär. Auf der anderen Seite zählt mich Pauli (in dem Privatbrief, den Du zitierst) zu „all reactionary efforts“. Kannst Du mir verdenken, wenn mir dabei der Gedanke kommt, vielleicht bin ich weder das eine noch das andere, sondern bloß einfach vernünftig?*" ["It is amusing for me how your critics attack me from the left then from the right. On one side I am a wild revolutioner. On the other Pauli counts me (in the private letter you are citing) to the "all reactionary efforts". Can you blame me if a thought comes to me that I am neither the one nor the other, but rather simply reasonable/sensitive"] (Schrödinger 1953). His sensitivity and reasoning played an important role in his study of nature. The poet and the

scientist Erwin Schrödinger are side-by-side. According to Paul Valéry, poetry risks creating a strange foreign (*étrange*) language within the language, the poetic relationship to the world demands to free oneself from common understandings and explore the unknown (Luy 2006). “The question is not so much how you can mimic a science [...] but how much risk one can take in allowing one’s words to be modified by the world” (Latour, 1997). Schrödinger’s bilingual experience and his ability to converge viewpoints that were very foreign to one another have made it easier for him to take risks.

Languages have their shadows. Bilingualism can mean expressing oneself in twin worlds. Writing in an adopted language is, in a way, using a language in a language, as by Peter Schlemihl’s shadow of the German poet and natural scientist of French origin Adelbert von Chamisso (Chamisso 1814). As already pointed out, bilingualism and exophony have rarely been topics in the history of science. No wonder, when the need for more research on bilingual literary writing and poetry written in an adopted language has been recognized only in recent decades, and was for a long time predominately related to colonialism studies. The bigger quantity of Schrödinger’s poems, and the deeper poems, are written in his (more) native German. The English poems are light love verses. Yet, bilingual writing must have been important to him more than only to address his beloved women since he published his German-language and his English-language poems in one collection, and added some of his poetic translations of English poets into German. In his articles and essays he also used both English and German.

Bilingualism is now a common feature in society, and still we know little about its influence on scientific research. The translation of exophonic texts is discussed more in the literary studies (Wright 2010). Linguists and translators point out that the presentation of evidence and the style of argumentation in scientific texts depend on the used language (Schröder 1995, Fix et al. 2001). Schrödinger was aware of this and sometimes did not give up the shadow of his native German when working on a scientific paper in English. As an author of literary texts he obviously clearly insisted on his bilingualism, as an author of his scientific texts he sometimes preferred to stick to his (more) native language. This contradictory is only one of the many that the personality of Erwin Schrödinger carried and united. In his lectures in Dublin in 1943 he calls the language a “garment” and when using translations of his papers by others, admits to “reluctance to give up some “original” fashion” of his own (Schrödinger 1944). From the point of view of research into exophony, it would be important to examine which words these were and what choosing them instead of more standard words means for the scientific content of the paper.

The bilingualism of Schrödinger’s work deserves more recognition and research, especially given the backdrop of increasing cultural and linguistic diversity within today’s classrooms. There is some interest in Schrödinger’s poetry in educational circles (Wohlmuth 2007), and on the example of verses by Richard Frost related to Schrödinger’s scientific ideas, some authors point out the usefulness of incorporating literature into the teaching of physics as a means to heighten student interest and increase their level of understanding (Coelitta et al. 1992). Once introduced to the different aspects of Schrödinger’s work, a group of MIT students were enchanted by its broad scope and by his complex multilingual expressiveness (Sofronieva 2012).

Conclusions

Many know that Erwin Schrödinger is a quantum physicist; some connect his name with the biology and philosophy of science, but only few to bilingualism and poetry. His poetic work encompasses poems in two languages, literary translations, essays, autobiography, and a dialogue. The investigation of several German poems by Schrödinger has shown his work as a poet to be closely related to his ideas in science. It challenges the existing assumption that the poetic activity of the great physicist is not valuable or interesting for the history of science and proves the need for its revision. To a large degree this assumption is based on critics' preoccupation with his love poems and reflects a purely biographical approach to his poetry. This one-sided reading of his literary work is also related to the marginal position accorded Schrödinger in the scientific and literary communities. His bilingualism supported his poetic marginalization.

Schrödinger's poetry illustrates the interplay between literary imagination and scientific investigation. Several of his German poems show how deeply and emotionally concerned their author was with the interpretation of his ideas in physics and with the inability of man to achieve full understanding of nature. The role of poetry in Schrödinger's life and work was stronger than has been previously assumed. Schrödinger's work in literature and his own perception of himself as a poet illuminate the importance of the imagery of poetic language in his work as a scientist. Schrödinger's literary imagination and his bilingualism are an integral part of his approach to reality. Their role in his scientific work and the understated role of bilingualism and exophony in science need further research. All these aspects of Erwin Schrödinger's work in poetry make it a historical source which can make a valuable contribution to the studies of the relationship between science and literature.

Erwin Schrödinger's legacy is a great example of the fact that scientists do not research the world outside of us but rather the relationships between it and us, and that "a man lives in history, not in nature" (Pasternak 1988). The portrait of the scientist Erwin Schrödinger becomes complete only after adding the "other" Schrödinger, only after considering the sensitive vibrations of the poet.

Bibliography

1. Adams, C. (1982). The Story of Schroedinger's Cat (an epic poem). In *The Straight Dope*. <http://www.straightdope.com/columns/read/113/the-story-of-schroedingers-cat-an-epic-poem>. Accessed 15 February 2012.
2. Albright, D. (1997). *Quantum Poetics: Yeats, Pound, Eliot, and the Science of Modernism*. New York: Cambridge University Press.
3. Апостолова, И. [Apostolova, I.] (1990). *Научна общност и философски предпоставки [Scientific community and philosophical premises]*. Sofia: Nauka i izkustvo.

4. Armine, F. & Cohen, R. (Ed.) (1989). *Literature and Science as Modes of Expression*. Boston: Kluwer Academic Publications.
5. Azzouni, S. (2007). How Wilhelm Ditley influenced Popular Science Writing. Kurd Laßwitz's "homchen: Ein Tiermärchen aus der oberen Kreide". In Feest, U. (Ed.). *Historical Perspectives on Erklären and Verstehen: An interdisciplinary Workshop* (pp. 49-66). Berlin: MPIWG Preprint 324, P. 49-66.
6. Benn, G. (2003). Rede auf Stefan George. In Wellershoff, D. (Ed.). *Gotfried Benn. Essays und Aufsätze, Gesammelte Werke*. Frankfurt: Zweitausendeins.
7. Born, M. (1953). The Interpretation of Quantum Mechanics. In *British Journal for the Philosophy of Science*, 4 (14), 95-106.
8. Born, M. (1954). The Statistical Interpretation of Quantum Mechanics. Nobel Lecture. http://www.nobelprize.org/nobel_prizes/physics/laureates/1954/born-lecture.pdf. Accessed 10 December 2012
9. Callaghan, C. (2000). Schroedinger's Cat. In *Dark Planet*. An Archive of Science Fiction, Modern Fantasy, Poetry, and Related Nonfiction. <http://darkplanet.basespace.net/poetry/schrocat.html>. Accessed 15 February 2012.
10. Carter, S. (1990). Robert Duncan and Erwin Schrödinger: Esthetics of the Wave Function. *Studies in the Humanities*, 17 (1), 36-48.
11. Chamisso, A. von (1814). *Peter Schlemihl's wundersame Geschichte*. Deutsches Textarchiv. <http://www.deutschestextarchiv.de/chamisso/schlemihl/1814/>. Accessed 30 April 2012.
12. Coletta, W.J. & Tarmes, D.H. (1992). Robert Frost and the Poetry of Physics. *The Physics Teacher*, 30 (6), 360-365.
13. Dick, A. (2008). Vorwort. In Schrödinger, E. *Mein Leben, meine Weltansicht* (pp. 5-10). München: dtv
14. Duncan, R. (1973). Towards an Open Universe. In Allen D. & Warren T. (Ed.). *The Poetic of the New American Poetry* (pp. 212-225). New York: Grove Press.
15. Erbefels, R. (2009). Schrödinger's Katze. In Schreiber, A. *Die Leier des Pythagoras: Gedichte aus mathematischen Gründen* (p.161) Wiesbaden: Vieweg+Teubner Verlag.
16. Eliot, T.S. (2004) Yeats. Lecture in the Irish Academy, Dublin 1940. <http://www.ancientsites.com/aw/Post/327817>. Accessed 30 April 2012.
17. Elkana, Y. (1992), Erwin Schrödinger as Historian – Notes towards an Interpretation. In Götschl, J. (Ed.) *Erwin Schrödinger's World View: The Dynamics of Knowledge and Reality* (pp. 115-134). Dordrecht: Kluwer Academic Publishers.
18. Fix, U., Habscheid, S. & Klein, J. (Ed.) (2001). *Zur Kulturspezifik von Textsorten*. Tübingen: Stauffenburg.

19. Fleck, L. (1979). *Genesis and Development of a Scientific Fact*. Chicago: The Univ. of Chicago Press.
20. Flitner, W. (Ed.) (1949). *Johann Heinrich Pestalozzi: Ausgewählte Schriften*. Godesberg: Verlag Helmut Küpper, formally Georg Bondi.
21. Forman, P. (1971). Weimar Culture, Causality and Quantum Theory 1918-1927: Adaptation by German Physicists and Mathematicians to a Hostile Intellectual Environment. *Historical Studies in the Physical Sciences*, 3, 1-115.
22. Foucault, M.(1973). *Order of Things: An Archeology of Human Sciences*. New York: Vintage.
23. George, S. (1958). *Werke in zwei Bänden*. München: Verlag Helmut Küpper, formerly Georg Bondi.
24. Götschl, J. (1992). The Study of Nature and the Emergence of World View – Philosophical Reflections on E.Schrödinger’s Approach. In Götschl, J. (Ed.). *Erwin Schrödinger’s World View: The Dynamics of Knowledge and Reality* (pp.173-182). Dordrecht: Kluwer Academic Publishers.
25. Götschl, J. & Leinfellner, W. (1992). Introduction . In Götschl, J. (Ed.) *Erwin Schrödinger’s World View: The Dynamics of Knowledge and Reality* (pp. 1-15). Dordrecht: Kluwer Academic Publishers.
26. Greiff, B. von (2001). Hat Galilei seine Zeit verschwendet? In: *Gegenworte* 7, 49-52.
27. Greiner, U. (2004). Da lachen die Fische.Bringt Poesie in unsere Städte! In *Die Zeit* 33 (2004), retrieved from: <http://www.zeit.de/2004/33/Glosse-Lit>. Accessed 15 December 2012.
28. Gribbin, J. (2012). *Erwin Schrödinger and the Quantum Revolution*. London: Bantam Press.
29. Heisenberg, W. (2007). *Physics and Philosophy: The Revolution in Modern Science*. New York: HarperCollins.
30. Heisenberg, W. (1971). *Physics and Beyond*. New York: HarperCollins.
31. Hubmann, G. (2001) Von der Notwendigkeit der Metapher. In: *Gegenworte* 7, 58-59
32. Irretier, H. (2011). *Grundlagen der Schwingungstechnik 2: Systeme mit mehreren Freiheitsgraden, Kontinuierliche Systeme*. Braunschweig/Wiesbaden: VerlagVieweg.
33. Keller, E. F. (1985) . *Reflections on Gender and Science*. New Haven and London: Yale University Press.
34. Kippermann, M. (1986). The Rethorical Case Against a Theory of Literature and Science. *Philosophy and Literature* 10, 76-83.

35. Koch, R. (1989). Hypotyposes. In Armine, F. & Cohen, R. Ed. (1989). *Literature and Science as Modes of Expression* (pp.81-99). Boston: Kluwer Academic Publications.
36. Latour, B. (1987). *Science in Action. How to follow scientists and engineers through society*. Cambridge: Harvard University Press.
37. Latour, B. (1997). Foreword. In Strengers, I., *Power and Invention: Situating Science* (pp VII-XVII). Minneapolis: University of Minnesota.
38. Levine, G. (Ed.) (1987). *One Culture, Essays in Science and Literature*. Madison: University of Wisconsin Press.
39. Lyu, Claire Chi-ah (2006). *A Sun Without a Sun: The Power and Elegance of Poetry*. Pittsburgh: University of Pittsburgh.
40. Moore, W. (1989). *Schrödinger Life and Thought*. Cambridge: Cambridge Univ Press.
41. Otis, L. (2010) Science Surveys and Histories of Literature: Reflections on an Uneasy Kinship. *Isis*, 101 (3), 570-577.
42. Пастернак, Б. [Pasternak, B.] (1988). Доктор Живаго. [Doctor Zhivago]. Окончательный авторский текст романа. *Новый мир* № 1—4.
43. Partington, L. T. (2012): Preface of the editor. In *The Atomic Poems of Margaret (Lucas) Cavendish, Duches of Newcastle, from her Poems and Fancies, 1653*. Emory Women Writers Resource Project.
<http://womenwriters.library.emory.edu/toc.php?id=atomic&keyword=partington> . Accessed 20 January 2012.
44. Perloff, M. (1981). *The Poetics of Indeterminacy: Rimbaud to Cage*. Princeton: Princeton University Press.
45. Planck, M. (1936). *The Philosophy of Physics*. New York: W.W.Norton
46. Plotinsky, A., (2004). “In Principle Observable”: Werner Heisenberg’s Discovery of Quantum Mechanics and Romantic Imagination. *parallax*, 10 (3), 20-35
47. Raman, V.V. & Forman, P. (1969). Why was it Schrödinger who developed de Broglie’s ideas? *Historical Studies in the Physical Sciences*, 1, 291-314.
48. Röseberg, U. (1992). Erwin Schrödinger’s position in the Einstein-Bohr Debate. In Götschl, J. (Ed.) *Erwin Schrödinger’s World View: The Dynamics of Knowledge and Reality* (pp. 135-152). Dordrecht: Kluwer Academic Publishers.
49. Renn, J. (1998). Rettung aus Sehnot. In Daston, L., Renn, J., Rheinberger, H.-J., *Visions* (pp 25-36). Berlin : Max-Planck-Institut für Wissenschaftsgeschichte.
50. Sagan, C. (2012). On Johannes Kepler’s Persecution. <http://www.youtube.com>. Accessed 15 February 2012.

51. Shapin S. & Schaffer S. (1985) *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life*. Princeton: Princeton University Press.
52. Shimek, S. (2001). *In Uncertain Times: Poetry, Physics, and the Representation in the Quantum Era*. Los Angeles: University of California.
53. Schröder, H. (1995). Der Stil wissenschaftlichen Schreibens zwischen Disziplin, Kultur und Paradigma – Methodologische Anmerkungen zur interkulturellen Stilforschung. In Stickel, G. (Ed.), *Stillfragen. Jahrbuch 1994 des Instituts für deutsche Sprache*. (pp.150-180). Berlin / New York: de Gruyter.
54. Schrott, R. & Jacobs, A. (2012). *Gehirn und Gedicht: Wie wir unsere Wirklichkeiten konstruieren*. München: Hanser.
55. Schrott, R. (1996). Die Mitte zurückgewinnen. Raoul Schrott im Gespräch mit Urs Engeler. *Zwischen den Zeilen*, 7/8 <http://www.engeler.de/schrottgesprach.html>. Accessed 15 December 2011
56. Schreiber, A. (2009). *Die Leier des Pythagoras: Gedichte aus mathematischen Gründen*. Wiesbaden: Vieweg+Teubner Verlag.
57. Schreiber, A. (2012). *Lob des Fünfecks: Mathematisch angehauchte Gedichte*. Wiesbaden: Springer Spektrum
58. Schrödinger, E. (1944). *What is Life?* http://whatislife.stanford.edu/LoCo_files/What-is-Life.pdf. Accessed 20 January 2012
59. Schrödinger, E. (1949). *Gedichte*. Godesberg: Verlag Helmut Küpper, vormals Georg Bondi.
60. Schrödinger, E. (1952). Are There Quantum Jumps? *The British Journal for the Philosophy of Science*, 3, 109-123 and 233-242.
61. Schrödinger, E. (1953) Brief von Schrödinger, Erwin an Born, Max ([Dublin], 1953-04-11). Nachlass Erwin Schrödinger o:260744. https://phaidra.univie.ac.at/detail_object/o:260744. Accessed 15 December 2012
62. Schrödinger, E. (1945). "Private" Texte, Briefentwürfe und Gedichte (en) In Österreichische Zentralbibliothek für Physik (Ed) Nachlass Erwin Schrödinger. https://phaidra.univie.ac.at/detail_object/o:163422?tab=92#mda Accessed: 15 December 2012
63. Schrödinger, E. (1935). Die gegenwärtige Situation in der Quantenmechanik. Part 1-3. *Naturwissenschaften*. 23 (807-812; 823-828; 844-849). (The present situation in quantum mechanics). Translated by John D. Trimmer. *Proceedings of the American Philosophical Society*. <http://www.tu-harburg.de/rzt/rzt/it/QM/cat.html#sect5>. Accessed 30 April 2012
64. Schrödinger, E. (1935). *Science And The Human Temperament*. London : Allen & Unwin.
65. Schrödinger, E. (1954). *Nature and the Greeks*. Cambridge: Cambridge Univ. Press.

66. Schrödinger, E. (1955). Fragment From An Unpublished Dialogue of Galileo. Time: Between 1910 and 1920. In Archive. The King's Hospital boarding school, Dublin. <http://www.kingshospital.ie/thekingshospital/Files/Schroedinger%20Bluecoat.pdf> Accessed 20 October 2012
67. Schrödinger, E. (1926) Quantisierung als Eigenwertproblem I-II. *Annalen der Physik* 79, 361-376, 489-527.
68. Schrödinger, E. (2006). *Mein Leben, meine Weltansicht*. München: DTV Deutscher Taschenbuch.
69. Schrödinger, E. (1987). *La mia visione del mondo. La mia vita. Poesie*. Milano: Garzanti.
70. Shinn, T. & Whitely, R. (1985). Editorial Preface. In Shinn, T. & Whitely, R. (Ed.) *Expository Science: Forms and Functions of Popularisation* (pp. VII-XI). Dordrecht: D. Reidel Publishing Company.
71. Sofronieva, T. (2012). Das Vererben vom Wissen. In Chiellino, C. (Ed.). *Michael Krüger. Eine Einführung mit Materialien und einer Bibliografie* (pp.107-126). Dresden: Thelem Universitätsverlag.
72. Sofronieva, T. (2012). *Words, Worlds, and the In-Between*. Internal Paper. Cambridge: MIT FL&L
73. Stein, G. (1933). *The Autobiography of Alice B. Toklas*. New York: Random House.
74. Trenn, T.J. (1979). Preface. In Fleck, L. *Genesis and Development of a Scientific Fact* (pp. XIII-XIX). Chicago: The University of Chicago Press.
75. Watson, J. D. (2001). *The Double Helix: A Personal Account of the Discovery of the Structure of DNA*. New York: Touchstone.
76. Weininger, S. J., (1989). Introduction: The Evolution of Literature and Science as a Discipline. In Armine, F. & Cohen, R. Ed. (1989). *Literature and Science as Modes of Expression*. Boston Studies in the Philosophy of Science, V. 115, pp. XIII-XXV. Boston: Kluwer Academic Publications.
77. Wikipedia. Erwin Schrödinger. Personal life. http://en.wikipedia.org/wiki/Erwin_Schr%C3%B6dinger#Personal_life. Accessed 20 January 2012
78. Wikipedia. Schrödinger's Cat in the Popular Culture. http://en.wikipedia.org/wiki/Schr%C3%B6dinger%27s_cat_in_popular_culture#Literature. Accessed 20 October 2012
79. Wikipedia <http://de.wikipedia.org/wiki/Lyrik> Accessed 15 December 2011
80. Wohlmuth, M. (2007). Gedanken über ein Gedicht des berühmten Physikers Erwin Schrödinger. In *Praxis der Naturwissenschaften - Chemie in der Schule* 56 (7), (32-33).
81. Whorf, B. (1956) *Language, Thought and Reality*. Cambridge: The M.I.T. Press.

82. Wright, C. (2007). »BRINGT POESIE IN UNSERE STÄDTE!« Obrigkeitsdeutsch and Exophonic Literature. In Sofronieva, T. (Ed.) *Verbotene Worte. Digital Anthology*. Kakanien revisited. http://www.kakanien.ac.at/beitr/verb_worte/CWright1/?page=4 Accessed 15 December 2012
83. Wright, C. (2008) Writing in the “grey zone”: Exophonic literature in contemporary Germany.” *GfL – German as a Foreign Language*, 3, 26-42.
84. Wright, C. (2010). Exophony and Literary Translation. What it means for the translator when a writer adopts a new language. *Target – International Journal of Translation Studies*, 22.1, 22-39.
85. Yeats, W.B. (1958). *The Collected Poems*. London: Macmillan & CO LTD .