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Historical Records of Australian Science

'The border problems of science and philosophy': Ilse Rosenthal-Schneider and post-World War 2 science in Australian academia and society

Daniela K. Helbig[A,*] and Maureen A. O'Malley[A]

For full list of author affiliations and declarations see end of paper

*Correspondence to:
Daniela K. Helbig
School of History and Philosophy of Science, The University of Sydney, Carslaw Building, Sydney, NSW 2006, Australia
Email: daniela.helbig@sydney.edu.au

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ABSTRACT

Ilse Rosenthal-Schneider (1891–1990), a refugee immigrant to Australia in 1938, was a student of Nobel Prize-winning physicists, Einstein, Planck, and von Laue. She combined a background in physics, especially relativity theory, with a philosophical focus on the nature and possibilities of knowledge. As well as working at the University of Sydney to teach science students how to recognise philosophical issues in their subjects, she drove a major outreach programme to regional towns in New South Wales, where she was fêted by her audiences as a highly accomplished science communicator. Her best-known book, published in 1980, examined her interactions with Einstein, Planck, and von Laue by expanding on how all of them understood the relationship between science and philosophy. Rosenthal-Schneider never achieved a great deal of recognition, due in part to the limited opportunities for women of her era, but also due to her insistence on bridging disciplines and engaging in a scientific and philosophical dialogue beyond academia. We will show how Rosenthal-Schneider explored the borderlands of science and philosophy throughout her life, as she argued for the relevance of philosophical questions to practising scientists and non-academic publics in Australia.

Keywords: Einstein, history and philosophy of science, interdisciplinarity, modern physics, Planck, post-WW2 science, refugees in Australia, von Laue, women in STEM.

Introduction

The pages of this journal celebrate the scientific careers of a small number of women, all of whom are distinguished by remarkable achievements in the very male world of early- to mid-twentieth-century science in Australia. For example, articles can be found that chronicle the lives and achievements of chemists Ruth Gall and Jean Youatt,[1] microbiologist Nancy Millis,[2] mathematician Hanna Neumann,[3] geologist Dorothy Hill,[4] and gastroenterologist Charlotte Anderson.[5]

Although Ilse Rosenthal-Schneider is not one of this illustrious group, we suggest she rightfully has a place in the history of science in Australia. Trained in Germany between the World Wars, she specialised in a combination of physics and philosophy. Her mentors and teachers were the internationally renowned physicists, Albert Einstein, Max Planck, and Max von Laue. She brought these connections and her philosophical views on

[1] Allen (1994).
[2] Pittard (2013).
[3] Newman and Wall (1975).
[4] Campbell and Jell (1998).
[5] Allen (1996). Other articles in this journal cover: biophysicist Mollie Holman—McLachlan and Hirst (2013); asthma researcher, Ann Woolcock—Smith (2014); marine biologist Shirley Jeffrey—Wright and others (2016); and photosynthetic membrane biologist, Jan Anderson—Horton and others (2019). There are also interviews with women scientists published as transcripts on the website of the Australian Academy of Science, but which are not published as historical articles or memoirs (for example interviews with physicist Jean Laby, geologist Beryl Nashar, and biochemist Pamela Rickard).

relativity theory and quantum mechanics to Australia, just before World War 2 began. Almost immediately upon her arrival in this country, she began giving public talks under the auspices of the University of Sydney, first on campus and then in far-flung regional areas of New South Wales (NSW). She did this to considerable acclaim for more than twenty years, with the aim of translating the implications of theoretical physics for post-war society. At the same time, she taught two generations of students on campus about the historical and philosophical aspects of the physical science they studied. And yet, despite all this activity, the media attention it attracted, and the popular following she inspired across the state, Rosenthal-Schneider has almost disappeared from the historical record.

Themes of 'invisibility', 'disappearance', and 'effacement' are common in many historiographies of Australian women scientists.[6] In this article, however, we turn to Rosenthal-Schneider's life story not just as a belated recognition of a woman's forgotten achievements, but also to foreground her views on the place of science in society. We show that she carved out a career by insisting on the importance of philosophical questions in science for practising scientists as well as the wider, non-academic public in Australia. Throughout her body of written work she emphasised the continuity between science and its philosophy. As we argue here, this position was not only the result of her intellectual background in early twentieth-century Berlin, but also of her outreach work in Australia and how that work was shaped by academic conditions for women of her time. However, we also emphasise the room for inventiveness in a career structured by those conditions, and how opportunities can be seized even in straitened circumstances.

Our account is organised along biographical lines. We draw on archival and published records to trace Rosenthal-Schneider's educational background, refugee arrival, and the advantage she took of her famous physicist mentors once she settled in Australia.[7] As a woman, there were limited institutional opportunities for her in Australian universities of the time. Using newspaper and magazine articles from various locations across regional NSW, we show how she circumvented those restrictions as she conducted a mission of broader public education on Einsteinian physics combined with Kantian philosophy. We document the remarkable success of this outreach programme, and emphasise the receptivity of regional Australia to this bigger picture of science. Far from finding it esoteric or irrelevant, Rosenthal-Schneider's message of how science was a vital part of society, and could improve lives materially as well as culturally, had a considerable impact in both town and country. And yet part of the reason for Rosenthal-Schneider's disappearance from the institutional record is probably owed to her very refusal to respect emerging boundaries between science and philosophy as academic departments became more specialised.

The formative years: Berlin

Born in 1891 to a middle-class family with Jewish ancestry, Ilse Ann Marie Felicia Schneider grew up in Finsterwalde, a north-eastern German town between Berlin and Dresden, where her father was a district court judge. She moved to Berlin in 1909 for her university studies. The opening of university gates to women that very year, after three decades of an official ban on female students,[8] gave Schneider academic opportunities unavailable to the preceding generation. Family connections in Berlin provided respectable living arrangements for a single woman, as well as social opportunities amongst the cultured milieu of her relatives.[9] One of the few available photographs of Schneider's student years shows her on assignment to a Berlin military hospital during the First World War (Fig. 1).

Her educational focus was not, however, medicine: it was physics, philosophy, and ancient Greek, and she made the most of Berlin's extraordinary scientific environment during the first few decades of the twentieth century. She was among the students who took Albert Einstein's first course on relativity in Berlin in 1914/15. For her doctoral dissertation she worked with the eminent Neo-Kantian philosopher, Alois Riehl, but also with three Nobel-prize winning physicists who stood out for their profound philosophical interests: Einstein, Planck, and von Laue. She found all three to be both eminently approachable and keen to discuss the philosophical implications of their scientific work. While attending lectures given by Einstein after he took up a position in Berlin, Schneider found that his 'extreme modesty and simplicity' meant 'you could speak freely, ask and answer questions, without feeling embarrassed' and thus become clearer on the basic underlying issues.[10] These interactions were not limited to classrooms: Schneider regularly met Einstein on the tram and had individual discussions with both with him and Planck in their university offices; von Laue also invited her to his house to discuss her doctoral thesis.[11]

Schneider's early research addressed problems that philosophers and physicists had been grappling with since the

[6] Moyal (1993). Turner (2007). Stevenson (2014). Kelly (1993*a*). Pickles (2001).
[7] There are few personal documents by Rosenthal-Schneider herself, but some family-related archival material can be found in collections in Munich and Oxford. Andrea Reichenberger has documented much of Rosenthal-Schneider's early work—Reichenberger (2020)—and our research has benefited from ongoing conversations with her.
[8] Mazón (2003).
[9] Kunze (2015).
[10] Rosenthal-Schneider (1955) p. 20. Rosenthal-Schneider (1980*a*).
[11] Rosenthal-Schneider (1980*b*).

Fig. 1. Ilse Schneider in World War 1, working as a clinical sample analyst at the Berlin Tiergartenhof military hospital. Credit: Wayne State University Press (out of copyright).

turn of the century in light of the 'new physics' (Staley 2005). A fundamental issue was the relationship of concepts that make sense of the world to sensory experience gained from the world. Although this might seem like an abstract philosophical problem, physicists were also debating this issue as a matter of urgency when the notions of atoms and sub-atomic particles entered the field around 1900. Relativity theory added new puzzles. How do concepts capture an utterly unintuitive reality, such as that of relativistic space-time? Relativity theory provides mathematical tools with which to describe this space-time structure, but the pressing question was whether these equations captured some deeper physical reality, or were merely mathematically convenient descriptive conventions.

Schneider addressed such questions through Immanuel Kant's philosophy. His work was the most significant philosophical tradition in the German context (and for some philosophers, the entire history of philosophy), but also an approach that was widely thought to be challenged by new developments in physics. Schneider disagreed. In a remarkable article on the French physicist and philosopher Henri Poincaré, whose mathematical reformulation of the Lorentz transformations paved the way for Einstein's theory of special relativity, she suggested that Poincaré's view of geometric axioms as conventions (rather than unchanging truths) had its historical roots in Kant's arguments about the nature and possibility of knowledge. Schneider argued that Kant's view of basic intuitions about space, time and causality grounded the very possibility of perceiving geometric phenomena.[12] She then developed this interpretation in a bold doctoral thesis that argued that Einstein's theory of general relativity was not just compatible with, but was in fact an example of, a physical theory that illustrated Kant's argument for the possibility of scientific knowledge.[13]

Fusing her Neo-Kantian training from Riehl with the physics she had learned from Einstein and Planck, Schneider emphasised that space and time were for Kant 'pure forms of intuition' (that is, organising principles for our sensory experiences) rather than 'anything real in itself'. These organising principles were thus not in conflict with the notions of space and time in Einstein's theory of relativity. In fact, such principles provided the very basis for changing views of physical reality.[14] This position aligned Schneider with prominent Neo-Kantian philosophers of physics such as Ernst Cassirer, but put her at odds most notably with fellow former Einstein student, Hans Reichenbach. He became one of the most influential philosophers of science in the twentieth century, leading a movement (logical empiricism) that started with an insistence on overthrowing Kantian principles.[15]

Schneider defended her thesis with Riehl and von Laue as examiners and was awarded a PhD in 1920. With encouragement from von Laue, the thesis was published as a book by the Berlin-based publisher Springer.[16] In 1922, Schneider married physicist-engineer Hans Rosenthal (whose surname was then appended to hers). The couple's daughter, Stephanie, was born in 1923. Planning to continue her research and obtain an *Habilitation* (a license to teach in German universities and precondition for any professorial appointment, which was not very likely for a woman), Rosenthal-Schneider worked as a science journalist over the following decade while also maintaining close contact with her physicist mentors and the evolving state of theoretical physics.[17]

Schneider's years in interwar Berlin were also formative in another respect. She began her academic training at a time when the philosophy of science began to take shape as a specialised academic discipline. On the one hand, it became more of a philosophical sub-discipline rather than an actively shared dialogue between scientists and philosophers such as Schneider had cherished in her conversations with her mentors.[18] And on the other hand, philosophy of

[12] Schneider (1914).
[13] Schneider (1921).
[14] Schneider (1921) p. 66. Translated by D. Helbig.
[15] Reichenbach (1949). On the conflict between Schneider and Reichenbach, see Reichenberger (2020) pp. 149–151. Howard (1994) also covers the disputes, but with more sympathy for Reichenbach.
[16] Schneider (1921).
[17] Denz and Vogt (2005).
[18] Giere (1996).

science was becoming primarily an academic enterprise, without the continuity between philosophical reflection on science and engagement with broader, non-academic, publics. This public-facing nature of philosophy of science had been an important feature of the nineteenth century, especially as promoted by Hermann von Helmholtz and practised by Einstein himself, as a major public intellectual of a later generation. But despite this formative German context, much of Schneider's rejection of the boundaries forming around an exclusively academic and professional philosophy of science occurred not in the Berlin of her youth, but in Australia, where she forged a career against considerable odds.

Refuge in Sydney

Together with her husband and daughter, Rosenthal-Schneider left Nazi Germany five years after Hitler's National Socialist Party came to power in 1933. Her academic career prospects in Germany—already marginal because of being a woman—had been further curtailed by laws against Jews occupying government jobs, including those whose families had converted to Christianity generations ago. In early 1938, emigration as a refugee meant that Rosenthal-Schneider and her husband had to renounce all assets and property, apart from 10 Reichsmarks (around US$2.50 at the time). They also left behind broader family, colleagues and friends (many of whom would not survive the war) when they departed Germany initially for the United Kingdom (UK) where they had relatives. They reached Australia via Canada in July 1938 after a tumultuous year of uncertainty and upheaval, settling in the now-affluent eastern Sydney suburb of Vaucluse (probably with financial assistance from Rosenthal-Schneider's extended family and refugee support from the Australian Jewish Welfare Society).

Despite the troubled times (World War 2 was declared in Europe on 3 September 1939, and joined immediately by Australia), Rosenthal-Schneider threw herself into her new life in Sydney (Fig. 2). She rapidly began making contacts on the University of Sydney campus, assisted by letters from her mentors, but with no academic network of like-minded émigrés to ease the way. Her northern-hemisphere connections and confidence in her own ideas must have been convincing because she gave her first talk at the University of Sydney in the form of a public lecture, open to academics, on 'Border problems in science and philosophy' in April of 1939.[19] This was just nine months after arriving in the country, which meant her English-speaking skills and science communication strategies were already finely honed.

Fig. 2. Rosenthal-Schneider in the early Sydney years. Credit: National Archives of Australia, SP11/5.[22]

Her husband was recruited to the Australian government's munition work, with the consequence that Rosenthal-Schneider was considered a security risk by the government.[20] But while this classification and Australia's ambivalence (public and political) about Jewish refugees seem to have had limited impact on her early life in Sydney, any aspirations she may have had to become a tenured lecturer in physics or philosophy faced considerable obstacles.[21]

Although women had been admitted to the University of Sydney since 1882—a quarter of a century earlier than most universities in Germany—in most respects the situation for women in Australian academia was extremely limited and in fact going backwards in the post World War 2 period. No matter how stellar any woman was as a student, the best most could hope for was work as a laboratory demonstrator, research assistant, tutor or assistant lecturer.[23] In a few exceptional cases, permanent lectureships and even associate professorships were eventually bestowed, with biology and geology departments being the most likely patrons. However, any academic positions for women came without opportunities for ongoing promotion and were almost always at lower salaries and higher workloads than those of men at the same level.[24]

For women trained in the sciences, another option was to gain a position in a teaching hospital or government

[19] Anonymous (1939).
[20] Glaros (2012).
[21] For general background of Jewish immigration into Australia see Turnbull (2000).
[22] Sourced from Glaros (2012).
[23] Moyal (1993). Hooker (2004).
[24] Grimshaw and Francis (2014). Moyal (1993). Carey (2001*b*). McEwin (2018).

laboratory. For example, the Council for Scientific and Industrial Research (CSIR), which became the Commonwealth Scientific and Industrial Research Organisation (CSIRO) after 1949, was a refuge for some fortunate women who made major scientific contributions. Even so, their overall numbers were very low in the pre- and post-World War 2 years,[25] and there was government legislation that forced female scientists in such government agencies and the broader public service to 'retire' as soon as they married.[26] This situation in the 1940s and 1950s was famously exemplified by ground-breaking radio astronomer, Ruby Payne-Scott, who concealed her marriage for six years but lost professional standing and her pension when the marriage was discovered. She finally gave up in disgust and resigned when pregnant.[27] Even for low-paid demonstrator work in universities, unmarried women were the rule despite the occasional return of married women after bearing children.[28]

Being a married woman with a child was thus a major impediment to Rosenthal-Schneider's academic career. Neither in physics nor philosophy at the University of Sydney had any woman ever been hired for anything other than low-level work. In fact, the first permanent lectureship at the University of Sydney for a woman in physics occurred only in the 1990s,[29] with a similar situation in philosophy. But even when fully aware of their limited opportunities, women trained and working in science in Australia between the 1930s and 1950s expressed a 'narrative of equality',[30] in which the obstacles and unequal outcomes they experienced were bracketed and seen as irrelevant (Payne-Scott being an obvious exception to this trend of forbearance). Pride in personal achievements came foremost—well above principles of parity.

This pride should not be explained simply as the capitulation of women to patriarchal ideology, and the same caution applies to Rosenthal-Schneider's situation. Although the career dice were loaded against her having a secure academic position, it is not entirely clear we should regard her primarily as a victim of circumstance rather than an active creator of her life and career. Despite the social conditions of the time, it is certainly possible that having a degree of intellectual independence from the university was something she wanted and actively sought.[31] The 'forced migration' she experienced was not just about the loss of opportunities but also the opening up of new prospects.[32] Finding herself in a novel academic and intellectual context may have allowed Rosenthal-Schneider to throw career caution to the winds and not restrict herself to an approximation of a conventional academic position (unlike, for example, the male philosopher-physicists who went to the USA and gained professional standing and international acclaim, but at the cost of narrowing their intellectual focus).[33] We see the strongest evidence for this 'embrace and flourish' interpretation in the way she participated in a University of Sydney programme for engaging with the broader public in reflections on science and its achievements.

Outreach beyond Sydney

Remarkably, Rosenthal-Schneider managed to carve out a career from her precarious casual position at the university with considerable ingenuity, even as the scientific job market contracted for women after men returned from war. She achieved this career primarily by engaging in a project to bring academic knowledge from the big coastal cities to inland rural regions. Her work built on a distinctive feature of nineteenth-century Australian science: the importance of public discussions of science both through newspapers and public networks.[34] Through these channels, Rosenthal-Schneider reached a broad audience for the discussion of the role of science in the wake of the Second World War. While no personal documents are yet available to reveal Rosenthal-Schneider's more private recollections of how she achieved this outreach, archival material does allow us to reconstruct her contributions to the philosophy and public discussion of science. Our main sources are the advertising for, and reports of, her public lectures in the Sydney University student newspaper, *Honi Soit*, plus various regional newspapers that chronicled with gusto and reverence her frequent visits and diverse topics. Far from the regions being suspicious of foreigners, and especially Germans, Rosenthal-Schneider seems to have been warmly welcomed in these regional towns—at least according to the daily and weekly newspapers that kept everyone connected.

With basic science having showed its usefulness to society in wartime applications, post-war Australia continued to expect science to lead the way in recovery from the depredations of war.[35] Rosenthal-Schneider was able to capitalise

[25]Upstill and others (2021).
[26]Colley (2018). CSIRO (1950). Sheridan and Stretton (2004).
[27]Goss (2013).
[28]Carey (2001*a*). Carey (2001*b*).
[29]Sharma (2005).
[30]Carey (2001*a*) p. 14.
[31]See, for example, Pomata's (2013) argument that women who were independent scholars in the late nineteenth and early twentieth centuries greatly valued their independence and, in some cases, rejected more secure but less autonomous careers.
[32]Ash and Söllner (1996).
[33]Giere (1996).
[34]Way (2021).
[35]Upstill and others (2021).

on this optimistic view of social growth and progress; indeed, many of her talks indicate that she firmly believed clear thinking about science was exactly what society needed to chart the best course into future decades. She contributed to a major regional outreach programme organised by the University of Sydney's Extension Board (the remains of which are nowadays Continuing Education), in which scientific and other speakers went to regional centres to discuss the meaning and implications of contemporary scientific developments for the future of society.

Starting on campus with series of public lectures, she spoke on 'reality and scientific truth',[36] and engaged in a high-profile debate on the role of science in society and whether all science should be directed toward practical outcomes.[37] Rosenthal-Schneider dissented, making an argument for free inquiry and the pure pursuit of knowledge, which she aligned politically with individual rights and freedoms.[38] Her debating opponent was Richard Makinson, a young physicist with widely professed communist beliefs, who argued strongly that science had to submit to social requirements. Despite taking the opposite view from Rosenthal-Schneider on this particular topic (and in his broader political views), Makinson made considerable efforts in the physics department to support the teaching of history and philosophy of science to physicists and other scientists.[39] This was a project that ultimately fell to Rosenthal-Schneider to implement.

But in addition, these on-campus interactions provide a snapshot of social arrangements for researchers of the time. Makinson, as a male academic, had an official voice in the university, and his advocacy for a more socially embedded view of science appeared in official minutes of university meetings about curricula and other educational matters.[40] His controversial political statements in favour of communism were protected under conventions of academic freedom even when members of the federal parliament called for his sacking.[41] Makinson's wife, physics-trained Rachel Makinson, found research work with the CSIR/CSIRO, where—despite being married—she persevered in short-term contracts and overcame various discriminations to become one of CSIRO's most internationally acclaimed scientists, on basic and applied aspects of wool.[42] Richard Makinson also faced obstacles (he was passed over several times for promotion), but was successful in seeing the history and philosophy of science taught as part of the Faculty of Science undergraduate degree.[43] Lectures were team-taught, with Rosenthal-Schneider taking on the philosophical aspects of science, and a variety of lecturers teaching histories of specific fields such as mathematics, chemistry and physics. These courses continued to be offered after the first successful attempt in 1945, at least up until 1952, with Rosenthal-Schneider as the only consistent contributor to this programme. The aim of such courses, she argued in 1945 in a letter to the Dean of the Science Faculty, was to allow students to think generally about science and to be less constrained by the narrower specialisms recently institutionalised in Australian degrees.[44] This strategy would therefore give students a more reflective overview of science.

Rosenthal-Schneider brought this same attitude to bear on the regular 'Scientific German' classes she offered almost every term from the mid-1940s until the mid-1960s.[45] These were not German classes on literature or other aspects of the humanities; they were not even held within the Department of German but were provided by the Extension Board (sometimes on campus, other times at Rosenthal-Schneider's own home). Because the scientific curricula of the time still relied on chemistry, physics, mathematics and other subjects with cutting-edge articles available only in German, it was an obligatory part of any science course (even during and after the war) that students could comprehend these texts by acquiring a working knowledge of the requisite vocabulary and syntax. This was what Rosenthal-Schneider taught students at one level of these classes. At another deeper level, however, she taught them how to analyse scientific texts historically and philosophically, and to read critically and contextually. Quantum chemistry professor, Noel Hush, recalled attending one of these courses (he organised a personal one for himself), and he claimed the skills he gained from this broader approach were invaluable for his later ground-breaking scientific career.[46]

But it was off-campus and outside Sydney that Rosenthal-Schneider found her academic niche and received the most recognition. Working for the Extension Board, she carried out a programme of speaking engagements in regional centres throughout NSW. Starting in Wagga Wagga, in 1943, she addressed the issue of how Australians could adjust mentally rather than just materially to the post-war situation.[47] This topic was in demand for other regional towns.[48] In those talks,

[36] Anonymous (1941).
[37] Anonymous (1944*c*).
[38] See for example Rosenthal-Schneider (1954).
[39] Turtle (1987).
[40] Turtle (1987).
[41] Deery (2000).
[42] Glorfeld (2020).
[43] Anonymous (1945).
[44] Sarton and Diller (1946).
[45] For example Anonymous (1965).
[46] Reichenberger, personal communication (2021).
[47] Anonymous (1943*a*)
[48] Anonymous (1943*d*). Anonymous (1943*e*).

to encourage her audience members to feel optimistic about the post-war future, she used the metaphor of green shoots emerging from burnt trees after bushfires,[49] perhaps a reflection of her adjustment to the Australian context. Another series of public lectures the same year was organised by the Wagga Wagga School of Arts and the Extension Board.[50] She did not shy away from difficult and quite abstract themes, in this case the nature of reality and the reality of scientific knowledge despite historical changes.[51] She argued that the broader public needed to appreciate these basic philosophical issues so that they could be appropriately trusting *and* critical of science and the changes it wrought in society. In this respect, she continued a German and subsequent émigré tradition of reconciling the specialised sciences with broad personal philosophical and political development,[52] although she never explicitly referenced this tradition in her written work. One reason for such reticence might be because it would have sounded 'foreign' and 'highfalutin' to her Australian audiences, and so she always spoke generally on such themes.

In Wagga and elsewhere, her delivery was praised for its clarity, comprehensibility, and content,[53] whether she spoke on hard-core philosophical topics or the nuances of relativity theory. In Albury, as a guest of local Rotarians (still sponsored by the Extension Board), she used everyday examples, such as unusual weather occurrences, to illustrate points about statistics and human perception, while amusing the audience with her travel anecdotes.[54] The uses and risks of atomic energy were other topics,[55] as were telepathy and extra-sensory perception.[56] No matter which topics were on the speaking agenda, she dissected their implications with the same light but precise touch. Her intellectual pedigree, many languages, and Continental sophistication held great appeal for her regional audiences.[57] Perhaps the most enthusiastic praise for Rosenthal-Schneider can be found in a 1947 issue of the *Daily Advertiser* in Wagga, in which acclaim for the intellectual qualities of the 'distinguished speaker' flow into a description of her physical appearance (rather uncomfortably for today's sensibilities). The report gushes about how her audience 'went home with food for thought, stimulated by the speaker's ideas, her clear and fluent delivery, with amazement and admiration, too, at the quality of the intellect revealed. The handsome, sensitive face, framed by snow-white hair, seemed like a beautiful picture' (see Fig. 3).[58]

Fig. 3. Rosenthal-Schneider at her home in Vaucluse, 1949. Credit: Wayne State University Press (out of copyright).

The extent of Rosenthal-Schneider's travels up and down regional NSW (also to Canberra and Melbourne) in the 1940s and 1950s is chronicled in regional newspapers. These sources also reflect the extraordinary importance to regional communities of local newspapers. It is important to note, however, that public science programmes and university contributions to them were not uncommon at all. In fact, the public communication of science and university outreach programmes of the post-war decades that Rosenthal-Schneider participated in were part of a long tradition in Australia, from the public science circulating in the early years of the colony to the post-World War 1 conversion of women's academic training into civic contributions.[59] By bridging the elite-everyday and town-country divide, Rosenthal-Schneider exemplified a particular phase of university relationships to the rest of Australia. She was able to play this role because of the way in which her own research

[49] Anonymous (1943*b*).
[50] Anonymous (1943*c*).
[51] As above.
[52] For background see Kettler and Lauer (2005).
[53] Anonymous (1943*a*). Anonymous (1948).
[54] Anonymous (1944*b*).
[55] Anonymous (1947*a*). Anonymous (1946).
[56] Anonymous (1944*a*). Anonymous (1950). Anonymous (1948).
[57] See, for instance, Anonymous (1948).
[58] Anonymous (1947*b*).
[59] Orthia (2016). Horne (2016).

interests had developed in her non-standard academic niche. Although such outreach activities have been characterised as yet another largely female duty,[60] patriarchally imposed on top of any 'genuine' academic work (teaching and research), we find in Rosenthal-Schneider's own writing quite some evidence for a seamless continuity between the public-facing and academically oriented aspects of her life.

From Berlin to Sydney: academic writing

Despite, and perhaps even because of, the enormous ruptures to her personal life and her precarious position in Sydney, Rosenthal-Schneider continued to develop answers to the philosophical questions that grew out of her early work in Berlin. Having started out with discussions of relativity theory, she now turned to quantum physics and the problems it raised for the notion of causality. But as her publications attest, Rosenthal-Schneider did not take up 'mere' science communication as a consolation project after her emigration. Rather, her writings directed at an academic audience pursue a similar goal to her public outreach: they make a case for philosophical questions as a genuine component of science, just as her three main mentors, Einstein, von Laue, and Planck, had believed.

Among her few widely known texts is a chapter that she contributed to a hefty well-regarded collection of essays on Einstein that was published shortly after his seventieth birthday as a tribute to the man and his work.[61] She was the only woman among the twenty five contributors. The question that had motivated her dissertation work almost thirty years earlier, namely that of how the sensory world was comprehensible, was still at the core of this chapter. However, she changed her focus from the examination of Einstein's physical theories to that of how his philosophical ideas functioned as 'determining principles' in his work.[62] In contrast to Planck, whom she portrays as committed to a Kantian framework of connecting sensory experience with concepts, Rosenthal-Schneider sees Einstein's approach to the problem as 'perhaps deliberately, somewhat vague'.[63] But she is convinced that the principles guiding Einstein's work were grounded in certain philosophical presuppositions, above all 'the ideal of mathematical simplicity and of an epistemologically satisfying unification'.[64] She argues that this fitted Einstein's commitment to a notion of physical reality independent of its observation, which could be described in non-probabilistic terms. This position famously led him to characterise quantum mechanics as incomplete, and both Einstein and Rosenthal-Schneider anticipated this characterisation would be vindicated by future developments in physics.

The late 1940s and 1950s also saw Rosenthal-Schneider produce several reviews for *Isis*, the journal of the international History of Science Society. These mostly provided a clear English précis of German books on physics and philosophy,[65] and the best ones gave a little extra insight into the philosophical ideas of her three mentors.[66] She then had the painful task of writing three obituaries for the *Australian Journal of Science* as one by one her cherished mentors died.[67] But she also published substantive work in the *Australian Journal of Science* in the late 1940s that discusses 'border-problems of science and philosophy':[68] the very nature of observation, scientific laws, determinism, and scientific interpretation. These articles focus on arguments made by physicist-philosopher Arthur Eddington, physicist Erwin Schrödinger and his reflections on the problem of life, and Marxist historian of science, Boris Hessen.[69] She rounds out these discussions with a published version of a speech delivered in August 1952 to the Australian and New Zealand Association for the Advancement of Science,[70] in which she analyses the relationships of observers to observed phenomena, a conundrum made acute by quantum physics. This almost unknown cluster of essays (just two citations in total) does more than simply state and situate her philosophical views in light of academic debates of the time. She is actively demonstrating how philosophy was not merely a specialised academic activity, but the underlying foundation of basic science and thus the proper subject matter of the scientific journal in which she published these essays.

In 1980, some thirty years after these articles, and sixty years after her first book on relativity theory, Rosenthal-Schneider published her major piece of work in English: *Reality and Scientific Truth: Discussions with Einstein, von Laue, and Planck*.[71] The book is largely structured around

[60] Pickles (2001).
[61] Schilpp (1949).
[62] Rosenthal-Schneider (1949*b*) p. 131.
[63] Rosenthal-Schneider (1949*b*) p. 135
[64] Rosenthal-Schneider (1949*b*) p. 139.
[65] For example Rosenthal-Schneider (1950).
[66] For example Rosenthal-Schneider (1948*a*). Rosenthal-Schneider (1949*a*).
[67] Rosenthal-Schneider (1948*b*). Rosenthal-Schneider (1955). Rosenthal-Schneider (1960).
[68] Rosenthal-Schneider (1946) p. 123.
[69] Rosenthal-Schneider (1945). Rosenthal-Schneider (1946). Rosenthal-Schneider (1947).
[70] Rosenthal-Schneider (1952).
[71] Rosenthal-Schneider (1980*b*).

conversations between Rosenthal-Schneider and her three physicist mentors,[72] and follows a dialogic format probably inspired by the long tradition of teaching-learning conversations (for example, Galileo's *Dialogue* of 1632). By interspersing letters and recollections of her meetings with all three scientists, Rosenthal-Schneider positions herself as an inquirer seeking to learn from scientists, and also as a prompter, as she encourages each of them to articulate their understanding of the concepts with which they operate. The core topics fall on the borderline of physics and philosophy: universal constants of nature, concepts of substance and conservation, the nature of physical reality, the possibilities of knowledge. A key theme of the book is the shared resistance of Rosenthal-Schneider and her three scientists to Heisenberg's and Bohr's formulations of physics, on the basis that this post-Einsteinian approach required the abandonment of any objective reality.

The prominence of personal anecdotes did not help in making Rosenthal-Schneider's book palatable to philosophers of science. By this time in her life, she had told the main stories about 'her' three 'philosopher-scientists' many times, and the book recycles every one of these recollections in detail. A chapter that came out slightly earlier than the book,[73] is in fact nothing more than a string of anecdotes, from chatting with Einstein during tram journeys to various informal discussions after lectures and in her mentors' homes and offices. One of her anecdotes in particular has become famous because it features the telegram that informed Einstein of Eddington's 1919 solar eclipse data. As Einstein shows her this telegram, Rosenthal-Schneider rejoices that the recent eclipse measurements agree with general relativity theory. Einstein, however, shrugs off her observation, noting that his theory is correct regardless of whether observations confirm it or not.[74] The telegram event thus inserts Rosenthal-Schneider into both a historic and philosophical moment in physics. It is historical because the confirming observations were part of a major reconfiguration of fundamental physics, and it is philosophical because Einstein's words as witnessed by Rosenthal-Schneider are used as evidence of his view of the theory-observation relationship.[75]

For some commentators, such authorial strategies were unacceptable. Not only was the telegram story 'questionable', according to one commentary, but it was fabricated to make it seem that Einstein had Kantian views of theory and its empirical confirmation.[76] Another review of Rosenthal-Schneider's book deemed it 'needlessly long … and positively off-putting' for being 'too personal' in its attempts to impose Kant on the three physicists and give grounds for rejecting the Copenhagen interpretations.[77] Her PhD thesis, which laid the groundwork for all her thoughts on science and philosophy, was retrospectively deemed 'forgettable' when compared to the arguments of contemporaneous male philosophers.[78] However, these harsh criticisms are balanced by effusive praise from other commentators. 'Penetrating' and 'most illuminating' was one verdict;[79] another finds Rosenthal-Schneider's Kantian interpretations very helpful, and criticisms of the telegram story unfounded.[80] At the very least, these discussions show that the issues with which Rosenthal-Schneider grappled were still pertinent several decades after she began thinking and writing about them.

But the critical commentaries also raise the question of why Rosenthal-Schneider wrote what she knew would be her final book the way she did, as a series of philosophical observations strung together by letters with famous men. Does she rely so heavily on these mentors because she saw herself as a voiceless woman, unable to have a scientific and academic life of her own? Does she believe all she can do is drift intellectually in their wake and offer up praise and platitudes? Or is she deploying an actual strategy for both communicating science and making it more human? As she said in one of her last newspaper interviews (see Fig. 4),[81] the purpose of the book was 'to keep the views, and personalities, of the three physicists … alive for those who knew them and [bring them] to life for those who did not'. The personal qualities of these scientists feature frequently, whether it was to do with their intellect, modesty, political conscience, or basic humanity. And her personal connection to these men and their ideas is emphasised again and again, alongside not only her misunderstandings (as she played the role of the enquiring non-expert she projected onto the public) but also her own ideas about how their philosophical approaches fit together. Even if the book did not accord with the conventions of fully institutionalised academic philosophy of science, Rosenthal-Schneider chose a format that she had found to resonate with non-academic audiences as she

[72]The book has an appendix that focuses on Eddington's philosophy of physics. It is both philosophically and stylistically quite different from the main part of the book, and may have been included for want of another publishing home.
[73]Rosenthal-Schneider (1980*a*).
[74]Rosenthal-Schneider: 'But what would you have said if there had been no such confirmation?' Einstein: 'I would have had to pity our dear God. The theory is correct all the same' (Rosenthal-Schneider (1980*b* p. 74).
[75]See Holton (1968).
[76]Hentschel (1992) section 7.
[77]Hendry (1982).
[78]Howard (1994) p. 53.
[79]Elkana (1982) p. 247. Elkana refers to Rosenthal-Schneider's contribution to the Schilpp volume, which was slightly modified then reproduced in her main book.
[80]Palmquist (2010).
[81]In Smith (1983) p. 11.

Fig. 4. Rosenthal-Schneider in one of her last interviews, in 1983. Credit: *National Times*.

and they crossed disciplinary boundaries, all the while emphasising the ongoing relevance of philosophical questions to scientific practice.

Despite receiving both critical and friendly attention internationally, Rosenthal-Schneider's final book did not bring her back into the limelight in Australia, or even gain her new recognition from a later generation of academics. Gerhart Lowenthal, a nuclear physicist who helped establish the Australian Standards of Radioactivity and worked at ANSTO (the Australian Nuclear Science and Technology Organisation, formerly the Australian Atomic Energy Commission), took a keen interest in Rosenthal-Schneider's work and noted in print that he 'always regretted that the book and its authoress received so little attention in this country'.[82] He tried to have her letters to and from Einstein, von Laue, and Planck retained in Australian archives, but failed (except for photocopies); he did manage to have Rosenthal-Schneider's large library made into a special collection at the University of New South Wales (UNSW)—the University of Sydney probably having declined it. But despite a brief official celebration of its acquisition in 1990,[83] the collection was dispersed after a decade or so. In many respects, this dispersal of material precious to her intellectual and academic life is symbolic of her disappearance from historical view.

Why reflect on Rosenthal-Schneider today?

Little remains of Rosenthal-Schneider's work and life. The modest house where she lived for almost her entire five decades in Sydney was sold and obliterated for a lavish new mansion; the girls' finishing school where she worked briefly when first in Sydney (Hopewood House on Darling Point) was demolished for a high-rise luxury apartment block; her library in the form of a Special Collection at UNSW was disposed of; the University of Sydney has no digitalised record of her work except for the most minimal of employment records.[84] The School of History and Philosophy of Science at the University of Sydney, which might be thought of as the true recipient of her intellectual legacy, knew nothing of her until very recently. Alan Chalmers, a founding figure in the 1970s of the University of Sydney's institutionalised incarnation of this historical and philosophical approach to science,[85] said, 'I never heard a single word about her in my two decades as head of the unit' (personal communication, 2021).[86] Although the fortunes of history and philosophy of science as an institutionalised academic field have fluctuated, for a few decades—in Australia and internationally—the field was strong and growing.[87] But no Australian or other histories of history and philosophy of science even mention Rosenthal-Schneider's early ground-breaking efforts, even those focused on Sydney's struggles in this area.[88]

What do we learn by attempting to remove the cloak of invisibility from an apparently marginalised figure such as Rosenthal-Schneider? One lesson is an elaboration of the well-recognised struggles faced by women in twentieth-century academia. These occurred not just in Australia of

[82]Lowenthal (1985) p. 51.
[83]Anonymous (1991).
[84]No Extension Board archival records about Rosenthal-Schneider have yet been found by us or any historiographers of the University of Sydney. Further searches for such material will be part of a future project.
[85]See Turtle (1987).
[86]Chalmers, personal communication (2021).
[87]For example Dyason (1977), Anderson (2022).
[88]For example Turtle (1987).

course. Rosenthal-Schneider's career was about far more than obstacles and unequal opportunities, but there is no denying that the roles available to her shunted her intellectual efforts into what might be deemed a career cul-de-sac: lower status and insecure employment, limited research development and recognition, and a thorough-going dependence on male mentors to gain the limited opportunities available. One might even think that Rosenthal-Schneider's constant drawing on her relationships with three famous scientists is explained by her awareness and manipulation of the rules of the game.

And yet, we think there is another lesson to be learned from the meagre details of her life that we have managed to flesh out. The very conditions of any academic career for women of Rosenthal-Schneider's era (and earlier) meant that women's contributions gained limited official recognition and easily disappeared from historiographical view.[89] Not only did their work occur in the underlit background of academia, but any subsequent historiographical recovery of the lives and work of such women could often 'downplay their individual agency'[90] because of the lack of archival material on their personal views and day-to-day achievements. Our reconstruction of Rosenthal-Schneider's writings and activities suggests that her work is better read as testimony to her agency and choices than merely as a reflection of the extremely limited and underrated career options open to her.[91] All her writing demonstrates the deliberate embrace of an academic life in the blurry borderland between science and philosophy, in which she actively sought to develop an intellectual and public-facing approach that drew on the special insights of this location. She exhibited a remarkable skill in drawing diverse and difficult topics together, and communicating them to broad audiences. Her reliance on her three mentors may well have been a communicative strategy, to personalise otherwise highly abstract fundamental science and make it matter to people. She encouraged a deep interrogation of science, in both its pure and applied aspects, to be carried out by everyone affected by scientific developments. Rosenthal-Schneider's overall approach might thus be taken as a lesson for today's university, in which increased interaction with public views of science could be seen as a necessity for the future of academia and even science.

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[89] Maroske (1993).

[90] Pickles (2001) p. 274.

[91] See Kelly (1993*b*) for further accounts of 'purposeful women who … made the most of the choices open to them' and 'pushed boldly into new areas in academic research' (p. 75).

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Author affiliation
[A]School of History and Philosophy of Science, The University of Sydney, Carslaw Building, Sydney, NSW 2006, Australia.