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1 **Title page:**

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3 **“In my work here, I have found more than I could ever have hoped”-**

4 **ambitions, expectations and timing – Inge Lehmanns experiences with**
5 **inequality in science during her early career, 1910-30**

Formateret: Ikke Fremhævning

6

7 **or**

8

9 **Intellectually gifted, but inherently fragile – society’s view of female**
10 **scientists as experienced by seismologist Inge Lehmann, 1910-30.**

11

12 **struggle to become a scientists**

13

14 **Lif Lund Jacobsen**

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16

17

18 **Abstract**

19 Celebrated for her 1936 discovery of the Earth's inner core, seismologist Inge Lehmann (1888-
 20 1993) is best known for her 1936 discovery of the Earth's inner core. Originally trained in mathematics, she began working as a seismologist in the
 21 mid-1920s and continued in this field until the 1970s for fifty years, gaining international acclaim
 22 for her meticulous seismic research. For twenty-four of those 24 years she headed the Seismology
 23 Department of the Danish Geodetic Institute. When she began her career began work, it was rare for women to hold any
 24 academic positions. Yet, through her determination and hard work, she became a prominent figure in the field. This news that in 2015
 25 the Danish government created a fund to support research in Denmark and PhD students were expected to have a minimum of 20% Danish
 26 citizenship. Danish women scientists in PhD (At the US) by Inge Lehmann, who helped to establish the Danish Ministry of Higher Education and Science
 27 in 1912, initiated the Inge Lehmann Research-funding
 28 Program. To develop talent and promote more equal gender representation in academics and
 29 research.

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37 **1. Introduction**

38 The Danish seismologist Inge Lehmann (1888-1993) is best known for her 1936 discovery of the
 39 Earth's inner core. Originally trained in mathematics, she began working as a seismologist in the
 40 mid-1920s and continued in this field until the 1970s for fifty years, gaining international acclaim
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 42 Department of the Danish Geodetic Institute. When she began her career began work, it was rare for women to hold any
 43 academic positions. Yet, through her determination and hard work, she became a prominent figure in the field. This news that in 2015
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50 Critics, however, call the Lehmann Program biased and discriminatory. Recently, claims were made
 51 that her ~~The scientific legacy of Inge Lehmann was brought into the debate when a professor in~~
 52 ~~history claimed that her scientific credentials were as exaggerated, since that she 'only' discovered~~
 53 ~~the earth inner core. its~~ ~~Further~~ ~~More important than~~ ~~arguments suggeste~~ ~~argument was put forward that~~
 54 ~~her impressive academic career means that~~ ~~prove that she could~~ ~~did not have experienced~~ ~~gender-~~
 55 ~~based discrimination.~~ ~~Hence, the Lehmann~~ ~~the Program's legacy~~ ~~rational~~ ~~is~~ ~~was based on a false~~
 56 ~~narrative. Whereas~~ ~~the first claim is based on a verbal reading of Lehmann (1936) and ignorance~~
 57 ~~about the implication of a reflection of P-waves in the inner core, is easily dismissed based on~~
 58 ~~scientific evidence, the second claim is not so easily~~ ~~more difficult to disprove~~ ~~a~~ ~~since little is known~~
 59 ~~about Inge Lehmann's early~~ ~~her career before the 1930s-~~ ~~(although see, for example, Bolt and~~
 60 ~~Hjortenberg, 1994).~~

61
 62 ~~This article is an attempt to fill~~ ~~these historical~~ ~~gab in our~~ ~~historical~~ ~~knowledge~~ ~~Using newly~~
 63 ~~discovered, unpublished~~ ~~historical~~ ~~documents, this article will document~~ ~~documenting~~ ~~from Inge~~
 64 ~~Lehmann's graduate and postgraduate years. It shows the degree~~ ~~examine to~~ ~~what~~ ~~which~~ ~~degree~~ ~~her~~
 65 ~~gender~~ ~~played~~ ~~a~~ ~~decisive~~ ~~role~~ ~~in~~ ~~her~~ ~~experiences, and suggests~~ ~~exemplify~~ ~~discuss~~ ~~to~~ ~~what~~ ~~the~~ ~~extent~~ ~~to~~ ~~which~~ ~~her~~ ~~experiences~~ ~~were~~
 66 ~~was shared by~~ ~~ere~~ ~~representative of her~~ ~~contemporary~~ ~~female~~ ~~contemporaries in~~ ~~academia.~~ ~~academics.~~

67
 68 ~~The article is based on newly discovered documents from~~ ~~Inge Lehmann bequeathed her personal~~
 69 ~~archive that she bequeathed to her colleague, seismologist Erik Hjortenberg, who donated it~~ ~~them~~ ~~to~~
 70 ~~the Danish National Archives in 2015. There, the Inge Lehmann archival~~ ~~collection consists of~~
 71 ~~twenty-one boxes of notes, letters, manuscripts and references. Additionally, A~~ ~~number of~~
 72 ~~dditional~~ ~~letters from the 1910s and 1920s are held in the archival collections of Niels Bohr and~~
 73 ~~Niels Erik Nørlund.~~

74
 75 ~~Tables and historical context of Inge Lehmann's Table 1 in the study of women's in Denmark (tbl) and Table 2 in of Danish~~ ~~women in~~
 76 ~~academia, display the historical context of Inge Lehmann's achievements (table 2) is provided~~
 77 ~~below. The tables shows~~ ~~Together, they show that~~ ~~that~~ ~~women's~~ ~~'s~~ ~~entry~~ ~~in~~ ~~to~~ ~~the~~ ~~Danish~~
 78 ~~different aspects of~~ ~~academia~~ ~~predated~~ ~~landmark~~ ~~rights~~ ~~legislation. E~~ ~~The~~ ~~exceptions~~ ~~are~~ ~~is~~ ~~positions~~
 79 ~~of~~ ~~leading~~ ~~academic~~ ~~university~~ ~~leadership~~ ~~positions~~ ~~at~~ ~~university~~ ~~and~~ ~~membership~~ ~~in~~ ~~of~~ ~~the~~ ~~Royal~~
 80 ~~Society, where women were slow to appear. The content of the tables are exemplary and is not~~
 81 ~~a~~ ~~Rather than~~ ~~comprehensive~~ ~~lists~~ ~~of~~ ~~gender~~ ~~equality~~ ~~measures~~ ~~in~~ ~~Denmark, the tables capture~~ ~~but~~

provide a context for the female academic experience as background for in academia in the early years of Inge Lehmann's career. The Danish seismologist Inge Lehmann (1888-1993) is known for her 1926 discovery of the Earth's inner core. Originally trained in mathematics, she began working as a seismologist in the mid 1920s and continued in this field until the 1970s. For 24 years she headed the Seismology Department of the Danish Geodetic Institute. When she began her work, it was rare for women to hold any academic position. Yet, despite being the sole female in a male-dominated research community, she soon gained international acclaim for her seismic research.

Table 1: Landmarks for women's rights in Denmark

1875 Women are gain admitted to the university admittancecies (except into the study of theology).
 1899 Married women achieve gain the same (financial) rights as unmarried women.
 1903 Girls are permitted to attend high school on equal terms with boys.
 1915 Women secure the right to vote.
 1919 Legislation passes regarding stipulates equal pay for equal work for in civil serviceants.
 1921 Legislation passes that provides insures Equal Access for Women to All Public Service and Occupations (with the except for ion of clerical and military positions).
 1922 Married women gain the right to share in the legal custody of their children, (but not have sole guardianship).
 1924 Nina Bang becomes the first female m Cabinet Minister (Minister for Education)

Table 2: Firsts for women in Danish academia:

1875 Studied at a university (medicine), Nielsine Nielsen.
 1889 Obtained a degree in science, (entomology) Sofie Rostrup.
 1893 Earned a scientific doctorate (history), Anna Hude.
 1909 Earned a scientific doctorate in science (physics), Kristine Meyer.
 1915 Gained an academic university position at university (calculator), Julie Marie Vinter Hansen.
 1922 Founded the Danish Association of University Women is founded.
 1946 Becomes a university professor (history), Astrid Friis.
 1958 Becomes a science professor in science (organic chemistry), Bodil Jerslev.
 1968 Elected to the Danish Royal Academy of Science and Letters, Eli Fischer-Jørgensen (linguistics).

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~~The rest of the text is not for the purpose of the course and is not relevant to the course.~~

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2. Childhood and schooldays

Inge Lehmann was the elder of two sisters who grew up in Copenhagen in an intellectual family.

Their mother, Ida ne Tørsleff (1866-1935), came from a family of booksellers. Several female Tørsleff family members were part of the Women Rights Movement and significant public figures. Inge's cousins served as head of the Danish Girl Scouts, chair of the Danish Women's Society, and the Minister of Trade. Famously, her younger sister Signe, a single mother, became a school superintendent.

Inge's father, Alfred Lehmann (1858-1921), held a Masters Degree in Applied Science from Copenhagen Polytechnic. He established psychology as an independent research subject in Denmark after he set up a private Psychophysics Laboratory for experimental psychological research in 1886 (Moustgaard and Petersen, 1986). When the University of Copenhagen took over the laboratory in 1890, Alfred Lehmann was appointed interim 'docent' (a teaching post ranked just below professor). Financial constraints meant that he had to take on additional paid work until 1911, as a censor at a teachers' college, a librarian at the Royal Veterinary and Agricultural University, and as a technical drawing teacher. Not until 1910 was he appointed 'ekstraordinær professor' (professor without chair), and nine years later he was elevated to a professorship with chair. Alfred Lehmann's substantial number of scholarly publications on experimental and applied topics range from how emotions influence blood circulation, and the existence of occult phenomena (of which he was skeptical), to studies of the maximum yield of physical and intellectual work (for detailed descriptions of Alfred Lehmann's work, see Funch, 1986; and Pind, 2019).

Inge's parents had progressive views on education. In 1894 they enrolled her, and later her sister Harriet, at Hanna Adlers Fællesskole, the first co-educational school in Copenhagen where girls and boys were taught the same subjects together. This was highly unusual – most schools had separate academic tracks for boys and girls. For intellectually inclined girls, gender-segregation policies went even further. Exposing girls to intellectual exhaustion and stress during puberty was considered harmful. Hence, girls under seventeen years old were prohibited from taking the high school entrance exam, whereas boys, who were considered better suited biologically for such activities, could take the exam and enter upper-secondary school (high school) at age fifteen (Larsen, 2010). This policy persisted until 1903.

135 The experience of the founder of the school, Hanna Adler, as a woman in academia, inspired her to
 136 establish her co-educational school. In 1892, seventeen years after the University of Copenhagen
 137 admitted its first women students, Adler (1859-1947) and Kirstine Meyer (1861-1941) were the first
 138 two women to earn Master's Degrees in Physics. Meyer was also the first woman to gain a
 139 habilitation in Physics, the traditional prerequisite [foref](#) a professorship. Inspired by advanced
 140 pedagogy in the USA, Adler opened her school a year after completing her degree. As teachers, she
 141 hired several of her female co-graduates who were excluded from many of the jobs open to [their](#)
 142 male [academicscounterparts](#). At that time, women could not get university [positions-appointments](#)
 143 and, although their degrees qualified them to teach at [the](#) upper-secondary school (high school)
 144 level, [mostany](#) female college graduates found work as primary [\(elementary\)](#) school teachers. [As-a](#)
 145 trailblazing female academic, Hanna Adler firmly believed in gender equality. She was also the aunt
 146 of [the](#) physicist and Nobel laureate, Niels Bohr, and a frequent guest in the Bohr household.
 147 In autobiographical notes, Inge Lehmann described her schooldays as happy, marked by serious
 148 study without differential treatment of boys and girls (RA: Lehmann autobiographical note, [ca
 149 1970]: W84-258078).² Inge showed considerable talent in mathematics and physics, and her father
 150 was keen for her to pursue a degree in science. Kirstine Meyer taught her physics, and Thyra Eibe
 151 (1886-1955), known for her expert translation of Euclid's *Elementes*, taught mathematics. These
 152 female scientists were uniquely qualified to support Inge [Lehmann's](#) academic ambitions. With such
 153 role models, it is not surprising that the girl developed a strong sense of intellectual entitlement and
 154 belief in gender equality.

155

156 **Figure 1: Inge Lehmann (to the right) with fellow High School graduates, 1906 – the first-year**
 157 **[females-women-were-allow-to-graduate-d](#) [onequalterms-with-the-men](#) (Anon [\[1918\]](#)) [Frk. H. Adlers Fællesskole 1893-](#)**

158 1918 . Kbh.).



159
160

161 3. Studies at the Faculty of Science, University of Copenhagen

162 After passing her upper-secondary school graduation exams in 1906, Inge Lehmann worked as a
163 private tutor before ~~in the autumn of 1907, beginning~~ starting her studies ~~in mathematics in~~ the
164 Faculty of Sciences ~~at~~ the University of Copenhagen ~~—Denmark's only university, majoring in~~
165 ~~mathematics in autumn, 1907~~

166

167 Between 1875 and 1925, 369 women sat for final examination at the University. Of that total, 326
168 did so after 1900, when the overall number of students ~~had~~ also increased from between 2,100-
169 2,300 at the turn of the century to approximately 4,500 ~~enrolled in the university~~ in 1925. In the
170 Faculty of Mathematical Sciences, the first precise student count dates from 1912, at which point
171 146 students were enrolled, 22 of them women (for details on early female students at Copenhagen
172 University, see Grane and Hørby, 1993; Rosenbech, 2014; Phil, 1983). Thus, when Inge Lehmann
173 started at the Faculty, female students were no longer ~~a~~ ~~rarity~~, but neither were they numerous.

174

175 So far, no sources have been found that describe Lehmann's university experiences in Copenhagen.
 176 She is not mentioned in records linked with ~~any~~ other leading students at the faculty, such as Niels
 177 Erik Nørlund in mathematics or Niels Bohr in physics. Nor was she ~~part of~~ in the interdisciplinary
 178 study group, *Ekliptika*, which had ~~a number of several~~ women participants (Pind, 2014). Lehman
 179 lived at home ~~and~~, evidently, ~~focus~~ ing ~~entirely~~ on her studies. The earned fine grades on the first
 180 part of her degree examination in ~~the summer of~~ 1910 ~~resulted in fine grades~~ (RA: Københavns
 181 Universitet, Karakterprotokol Matematik, [1908]: 2. del).³

182

183 3.1 Studies at Newham College, Cambridge University

184 After graduation, Inge Lehmann was eager to study abroad. In the spring of 1911 she entered
 185 Newnham College, one of two women's colleges at Cambridge University, UK. Cambridge was
 186 renowned for ~~its~~ excellence in mathematics. A form of examination unique to the university was
 187 notorious for its scope and difficulty. ~~The~~ Mathematical Tripos covered theoretical and applied
 188 mathematics, plus subjects in astronomy and physics: ~~it was notorious for its scope and difficulty~~.
 189 The exam was ~~considered~~ so challenging that preparation traditionally involved equal parts
 190 theoretical study and physical activity – training both body and mind in order to strengthen the
 191 intellect. Even after modification in 1909 to counter falling enrollment and accommodate students'
 192 needs to specialize within ~~a single one~~ subject, the Mathematical Tripos remained equally
 193 prestigious and exceedingly demanding ~~and equally prestigious~~ (Warwick, 2003). By choosing to
 194 read mathematics at Cambridge, Lehmann revealed the depth of her ambition, but the English
 195 university's setting proved ~~to be~~ quite ~~unlike~~ different from what she had known in Copenhagen.
 196 Women had been eligible to sit for the Tripos since 1881. Yet, although ~~women they~~ could attend
 197 lectures, ~~women they~~ could not matriculate, attain full university membership, or be appointed to
 198 academic posts. Only in 1948 were women admitted to Cambridge on equal terms with men. Un-
 199 matriculated female students were denied access to laboratories and libraries. Since individual
 200 tutoring at Cambridge often ~~took place~~ occurred in conjunction with lab work, female students ~~found~~
 201 ~~themselves were, in effect,~~ prohibited from taking part in practical, hands-on experimentation, and
 202 could not be tutored by ~~the~~ male lectures (for further details on the experiences of female academics
 203 at Cambridge University, see, e.g., Evans, 2010; Richmond, 1997).

204 At Cambridge, the regular system of tutors, grants and student clubs was the prerogative of men,
 205 and this further marginalized female students. During the 1880s and 1890s, therefore, a parallel

206 system of laboratories, libraries and tutors exclusively for female students ~~had~~ gradually built up around
207 the two women-only colleges, Girton and Newham.

208 While Inge Lehmann knew about similar parallel systems in Denmark – the Women’s Reading
209 Society (Kvindelig Læseforening), for example – she had not experienced the degree of gender
210 segregation that prevailed in Cambridge. Even though Cambridge reformed its~~the~~ examination
211 system ~~at Cambridge was reformed~~ in 1909, making~~and~~ a number of vital resources ~~were made~~
212 available to female students via their colleges, it was still difficult for women to study freely. In
213 particular, restrictions imposed on socializing between students of different sexes were far more
214 onerous in Cambridge than in Copenhagen, and, ~~and they~~ posed a real obstacle to knowledg~~the~~
215 sharing ~~of knowledge~~.

216

217 **Figure 2: Newham College (Inge Lehmann Collection, The Danish National Archives)**



218

219

220 Niels Bohr completed his doctoral dissertation – *Studies on the Electron Theory of Metals (Studier*
221 *over Metallernes Elektronteori)* – in the spring of 1911 and planned to spend time at Cavendish
222 Laboratory in order to follow the experimental work of J. J. Thomson, the physicist.

223 Bohr's interaction with ~~Inge~~ Inge Lehmann in Cambridge is detailed by Aaserud and Heibron (2013). In May
224 1911, he wrote ~~his first letter~~, asking for her help ~~into~~ finding out which physics lectures would be relevant to his
225 areas of interest, laid out in the enclosed ~~a~~ copy of his doctoral dissertation. After reading the
226 manuscript, Lehmann brief outlined the lectures ~~she thought~~ he might find useful, ~~and ending~~ed her letter ~~by~~
227 expressing hope that they could meet up when he came to Cambridge (NBA: I. Lehmann letter, 2.
228 Mai 1911).⁴ This proved considerably harder than she had envisaged.

229 Bohr arrived in Cambridge at the end of September 1911. By early October, he had found an
230 apartment with ~~the~~ help ~~from~~of Lehmann and her network of friends. Over the next few months,
231 Niels Bohr and Inge Lehmann visited one another numerous times, ~~although~~but arranging ~~these~~
232 ~~these~~ visits was ~~always~~ troublesome: according to university regulations, Inge had to be chaperoned
233 when spending time in the company of a man.

234 On one occasion, shortly after Niels arrived in Cambridge, he was invited to Peile Hall, where Inge
235 ~~Lehmann~~ lived at Newnham College. Their meeting was ~~only~~ possible because Newnham's Vice-
236 Principal, Miss Strachey, had agreed beforehand to be present (NBA: Lehmann letter, n.d. [1911]).⁵
237 Another visit ~~had to be~~was cancelled because Inge ~~was unable to~~couldn't find a suitable chaperone
238 on a Sunday (NBA: I. Lehmann letter, 13. October 1911).⁶

239 A dinner party in early December 1911 proved particularly challenging. Inge was traveling to
240 Copenhagen to spend Christmas with her family, so Niels invited her, along with two male
241 mathematicians, to a farewell-dinner at his lodging. Before she could accept his invitation, Inge had
242 to ask him for the name of her chaperone. With that information, she could ask the principal of
243 Newnham Hall for permission to attend. She regretted the trouble, but wrote with resignation: "...
244 Cambridge is Cambridge" (NBA: I. Lehmann letter, 5. December 1911b).⁷ Wise from experience,
245 Bohr had already arranged for a friend to attend the dinner party with his sister. Unfortunately,
246 Lehmann informed him, that sister was also a student at Newnham College, and her presence would
247 not fulfil the requirements of effective supervision (NBA: I. Lehmann letter, 5. December 1911a).⁸
248 Eventually, the list of dinner guests grew so long that Bohr was afraid there would be no room for
249 them in his small apartment, or so he ironically wrote to Margrethe Nørlund, his fiancée.

250 This correspondence illustrates how the restrictive social conventions at Cambridge obstructed
251 interactions between students of different genders – including the exchange of knowledge. Inge
252 Lehmann unquestionably felt the restrictions most acutely, but Niels Bohr also grumbled about the
253 University's strict code of conduct, which he found quite absurd. Although Bohr was likely

254 influenced by his free-thinking aunt, Hanna Adler, there can be no doubt that social conventions
255 between students of different sexes were far less cumbersome at the University of Copenhagen,
256 where no formalized system of gender segregation ever existed and teaching and practicums were in
257 effect co-educational.

258 Lehmann went home for Christmas in 1911, expecting to return to Cambridge ~~at for~~ the start of ~~the~~
259 spring semester. In March 1912, Bohr decided he had nothing more to gain from staying in
260 Cambridge and moved on to Professor Ernst Rutherford's laboratory in Manchester, where he spent
261 the next six months developing his pioneering atomic theory.

262 It was during Christmas break that Lehmann decided not to return to Cambridge for the next
263 semester. She was profoundly overworked. She had spent 1911 preparing for the Mathematical
264 Tripos, and intended to sit for the ~~entrance~~ exam in the spring of 1912. ~~She was profoundly~~
265 ~~overworked.~~ It has generally been assumed that Lehmann abandoned her studies altogether because
266 her recovery from ~~this~~ utter exhaustion was so slow. She was literally unable to resume her
267 university studies for a long time (e.g. Bolt, 1997).

268 In reality, she was exhausted, but also keen to return to Cambridge. Recently discovered
269 correspondence shows that Alfred Lehmann put a stop to her plans by refusing to fund ~~her~~
270 ~~stay~~them. Instead, he urged her to seek employment in Denmark and make a living outside
271 academia. In a letter to Inge written in March 1912, her father explained his reasoning at length.
272 Practically speaking, the rising cost of living made it impossible for him to finance her studies any
273 longer. Alfred's economic concerns seem genuine, given his precarious employment at the
274 University and his younger daughter Harriet's recent enrollment at the Danish Royal Theatre's
275 acting school. Yet, Inge's health was of primary importance. To protect his daughter, he could no
276 longer in good conscience support academic aspirations that were ruining her health. To Alfred and
277 many of his peers, it was a proven fact that, whereas women might be as intellectually gifted as men,
278 they lack the rigorous constitution necessary for academic pursuits. College was better suited to the
279 male disposition.

280 To argue his case Alfred Lehmann quoted several male professors of his acquaintance who strongly
281 believed that women did not have the mental stamina to meet the 'by no means unreasonable
282 requirements' for an MA in Copenhagen, let alone the more challenging studies in Cambridge. He
283 went on to relate "...a series of sad examples of how it went with intellectually gifted women who

284 wanted something more...". Their studies ~~had~~ made them so ill; that they were forever in and out of
 285 nerve clinics; if not half insane. Not wanting the same fate for Inge, who already had shown signs
 286 of fatigue, her father felt it would be irresponsible of him to let her continue with her studies.
 287 Instead, he urged his daughter to seek practical clerical employment where she could undoubtedly
 288 rise to a valuable and responsible administrative position in due time. Thus, there ~~would was~~ be no
 289 need for her to complete her final exam (Private: A. Lehmann letter, 11. March 1912).⁹

290 The biological argument that women were not equipped with enough energy and fortitude for
 291 scientific studies likely originated in the rise of scientific medicine in the 19th century and, by
 292 extension, the study of biological gender. From 1890 to the late 1910s, Doctor Leopold Meyer
 293 published a series of influential medical texts in Denmark that problematized menstruation in
 294 relation to physical and intellectual work: due to their female physiology, too much exertion of the
 295 brain and nervous system would make women ill (Rosenbeck, 2014). Since Inge's father studied the
 296 body's reaction to physical and intellectual work, he was most likely familiar with Meyer's ideas
 297 and, therefore, concerned about his daughter's future in her chosen field.

298 Inge must have protested because Alfred – somewhat mollified – wrote again two weeks later to
 299 suggest that she convalesce at home until September. Then, mindful of her health, she should
 300 resume her studies at Copenhagen University. If her strength and her exam results were satisfactory
 301 at the end of a year, he would find the necessary funds for another year at Cambridge, where she
 302 could complete her MA-degree without sitting for the Mathematical Tripos. Ultimately, Alfred
 303 thought it ill-advised for Inge to pursue a foreign degree when a degree from Copenhagen
 304 University would better prepare her for employment in the Danish school system. To what degree
 305 Alfred's own precarious experiences in academic influenced his advice to Inge is unknown, but as a
 306 woman her job opportunities would be ~~very~~ limited in general and nearly non-existing at the
 307 university.

308

309 4. Gap years

310 Inge ~~Lehmann~~ took her father's concerns to heart and did not return to universityCambridge. The
 311 next six years of her life are sporadically illuminated in recently discovered autobiographical notes,
 312 written much later in hindsight. In them, she acknowledged that acute overwork and a lengthy
 313 recovery period led her to provisionally abandon her studies for the typical life of a middle-class
 314 working woman.

315 In the fall of 1912, a friend of her father's secured her an actuarial job at the insurance company.
 316 *Det Gjensidige Forsikringselskab "Danmark"*. Her choice of employer was not unusual given that
 317 the insurance business attracted many female academics with mathematical backgrounds. There,
 318 they could use their statistical knowledge and calculating skills in office environments where
 319 female clerks and typists had long been a common presence (Kragh, 2008).

320 Inge Lehmann remained at the insurance company for a number of years but expressed little interest
 321 in the business aspects of her work (RA: Lehmann, biographical notes [u.d.]: W84-258079).¹⁰
 322 When she was not promoted in step with her male colleagues, she recognized that gender was again
 323 the restricting factor. Passed over for promotion, and with the prospect of a male boss she found
 324 unacceptable, she considered relocating to Canada, but another bout of overexertion prevented her
 325 from emigrating.

326 Unable to secure a managerial position, Lehmann considered marriage. In February 1917, at the age
 327 of 29, she became engaged and resigned from *Danmark*, as employment was incompatible with
 328 matrimony. Only a month later she broke off the engagement in order to resume her studies and
 329 pursue an academic career (RA: I. Lehmann, biographical notes [u.d.]: W84-2580).¹¹ Inge
 330 Lehmann's decision to remain unmarried to further her academic ambitions was not an unusual
 331 choice at the time. Abstaining from marriage was common for university women until the 1920s.
 332 Thereafter, the number of married female academics increased but slowly (Rosenbeck, 2014). ~~Inge~~
 333 Lehmann embodied this trend as she remained unmarried; ~~and~~ without children all her life.

334

335 **5. Return to the University of Copenhagen**

336 In August 1918, Inge Lehmann finally resumed her studies at the Faculty of Mathematical Sciences
 337 [in Copenhagen](#). Two years later, she passed the second and final part of her examination with top
 338 grades, earning her MA. It is worth noting that Lehmann's lengthy period of study manifested a
 339 general tendency among female students at the Faculty. A survey of degrees completed between
 340 1916-1920 at the Faculty of Mathematical Sciences shows that a number of female students were
 341 enrolled for considerable lengths of time, and that female students in general were enrolled longer
 342 than their male counterparts (Københavns Universitet, 1925).

343

344 Alfred Lehmann passed away in September of 1921. Among many other things, this meant that
 345 Inge needed to secure a stable income. Also that year, an act was passed giving women equal access

346 to [public sector](#) employment ~~in the public sector~~, including all university positions. No longer forced to settle for [public](#)
347 [school](#) teaching, Inge Lehmann could now pursue a university career in mathematics with
348 concomitant salary, prestige and scholarly recognition.

349

350 **5.1 Assistant in the Faculty of Mathematical Sciences**

351 A small scholarship allowed Lehmann to study mathematics at the University of Hamburg for a
352 short period of time. After returning home again, she started work in March 1923 as assistant to
353 Professor Johan Frederik Steffensen in his Actuarial Mathematics Laboratory at the University of
354 Copenhagen. Inge's yearly income was DKK 700, plus a small bonus (RA: Københavns
355 Universitets Forsikringsmatematiske Laboratorium, Korrespondance: Konsistorium, letter 1. March
356 1923).¹² For this modest salary, she had to tutor students, assist in practicum sessions and grade
357 assignments. Grading mathematical problems after the practicums ate up a disproportionate amount
358 of her time, and it quickly became obvious that her income was not commensurate with the
359 demands of her duties.

360

361 Realizing this, Professor Steffensen tried on several occasions to secure better pay and conditions
362 for his assistant. In December 1924 he tried to get a reduction in her workload. A few months later
363 he complained to the Minister for Education that Lehmann's pay was considerably inferior to that
364 of other (presumably male) scientific assistants at the University and requested that it be brought up
365 to the same level as the others (RA: Københavns Universitets Forsikringsmatematiske
366 Laboratorium Korrespondance: Steffensen, letter 16. February 1925).¹³ The gap between her salary
367 and that of the others must have been pitiful, because the Ministry of Education was quick to act: in
368 April her salary rose to almost three times its previous level (RA: Københavns Universitets
369 Forsikringsmatematiske Laboratorium, Korrespondance: Konsistorium, letter 30 September
370 1925)!¹⁴

371

372 While working at the Laboratory of Actuarial Mathematics, Inge Lehmann had taken on part time
373 jobs, including translation and editing for another Mathematics Faculty member: Professor Niels
374 Erik Nørlund. In addition to his professorship, Nørlund had been appointed Director of the Danish
375 Geodetic Service (Den Danske Gradmåling) in 1923, with a mandate to reform and merge the
376 Service with the Topographic Division of the General Staff (Generalstabens Topografiske
377 Afdeling).

378

379 The role of teaching assistant and occasional secretary was traditionally the end of the line for many
380 women in academia, but Lehmann was not content in this ~~final~~ station. Having worked as Niels Erik
381 Nørlund's occasional secretary, in June 1925 she cautiously pointed out to him that she wanted a
382 research job: "I believe that I would venture to undertake calculation work, if it does not involve too
383 great a theoretical foundation in areas with which I am not familiar, whereas I am not so certain that
384 you would be served by my assistance with correspondence, as I understood to be your plan." (RA:
385 N.E. Nørlund, letter (I. Lehmann) 17. June 1925)¹⁵

386

387 Nørlund could not employ her as research assistant at the university, but he saw another opening for
388 her talent. He was in the process of reorganizing the Geodetic Service and needed to add
389 seismological stations to their activities. An annual contribution from the Carlsberg Foundation
390 made the project feasible, and for the next couple of years Inge Lehmann helped to set up the new
391 seismological stations. In 1926 she helped establish seismic stations in Copenhagen (COP) and
392 Ivittuut (IVI), Southwest Greenland, and in 1927 at Scoresbysund/ Ittoqqortoormiit (SCO), West
393 Greenland (for the early history of seismology in Denmark, see Lehmann 1987;¹⁶ Jacobsen, 2017;¹⁷
394 Dahl-Jensen, Jacobsen, Sølund, Larsen and Voss (submitted)).

395

396 Lehmann carried out the work of setting up and running the seismological stations in addition to her
397 work at the Laboratory of Actuarial Mathematics. In January 1927, restructuring the Geodetic
398 Service was so far advanced that she could resign from the Actuarial Laboratory and work
399 exclusively for Niels Erik Nørlund. The plan was for Inge to learn the science of seismology so she
400 could work in that field in the future.

401

402 As seismology in Denmark was in its infancy, Nørlund arranged for Lehmann to spend four months
403 abroad in the autumn of 1927 to immerse herself in the science. Part of her time was spent at the
404 precursor of the International Association of Seismology and Physics of the Earth's Interior
405 (IASPEI), then known as the International Seismology Association of the International Union of
406 Geodesy and Geophysics (IUGG) (for the history of IASPEI, see Rothé, 1981; Schweitzer and Lay,
407 2019). The IUGG bureau was located in Strasbourg;¹⁸ there, she spent several weeks learning to read
408 seismograms. After attending the IUGG General Assembly in Prague, she put this skill to good use
409 while studying with Beno Gutenberg at his home in Darmstadt, Czechoslovakia (Lehmann 1987).

410

411 **6. Director of the Seismology Department at the Danish Geodetic Institute**

412 In April 1928, Niels Erik Nørlund was appointed director of the newly formed Danish Geodetic
413 Institute (Geodætisk Institut). In May, Inge Lehmann was the second person in the country to sit for
414 the ‘magisterkonferens’ (equivalent to an MSc) in geodesy at the University of Copenhagen, a new
415 subject recently introduced at Nørlund's behest.

416

417 Her short apprenticeship abroad and her own studies were her only preparation for the examination,
418 which was tailored to her future job. In the written exam, she gave an ‘Account of the key methods
419 for the determination of the epicenter of a seismic activity’ (*Redegørelse for de vigtigste Metoder til*
420 *Bestemmelse af Epicentret for en seismisk Bevægelse*). Her final lecture considered cartographic
421 projection methods (Københavns Universitet, 1929), another essential area in the work of the
422 Danish Geodetic Institute.

423

424 By summer, Inge Lehmann was Director of the new Seismology Department at the Geodetic
425 Institute. She was responsible for running Denmark's seismological stations, along with a couple of
426 technical assistants. Although the job was mainly administrative and involved very little research, it
427 was a permanent position with the title and salary of a department head.

428

429 *Figure 3: Inge Lehman, Director of the Seismological Department of the Geodetic Institute, 1932*
430 *(Royal Danish Library)*



431
432

433 In a letter to Niels Erik Nørlund written that year, she expressed her pleasure and gratitude:
434 “I do not think I thanked you properly for my appointment [...] I could not have wished for
435 anything better. I have earlier been concerned that I was asking too much when refusing to be
436 satisfied with working in order to earn money, but sought a job in which I could really take an
437 interest. In my work here, I have [...] found more than I could ever have hoped. In return, I shall do
438 my utmost. It is no small thing to have the opportunity and permission to use all one’s strengths.”
439 (RA: N.E. Nørlund, letter (I. Lehmann) November 1928)¹⁶

440 Until she retired in 1953, Inge Lehmann was the only academic working at the Department of
441 Seismology. Due to her administrative duties, most of her research was performed in her spare time.
442 Overseeing stations in Denmark and Greenland gave her access to seismograms from several
443 locations and a range of instruments. As department head, she kept in contact with an international
444 network of colleagues. Her expertise in reading seismograms and vigorous correspondence with
445 leading seismologists paved the way for her discovery of the Earth’s inner core in 1936, which
446 earned her lasting international renown as one of the most influential seismologists of the 20th
447 century (Hjortenberg 2009).

448

449 **7. Discussion**

450 As an early female scientist in Denmark, Inge Lehmann is virtually unsurpassed in the level of
 451 employment she achieved and in the scientific recognition she received later in life. However, her
 452 graduate and postgraduate experiences reflect common features shared by ~~most~~ female academics
 453 of the time.

454 In her study of Danish female academics from c.1875 to c.1925, Rosenbeck (2014) identified four
 455 commonalities. These women mostly came from affluent families or academic families. Female
 456 students had higher average grades than their male counterparts, even though this gendered
 457 difference diminished as the number of female students increased around 1900. Female students
 458 also started their coursework far later than male students, although average age difference also fell
 459 over subsequent generations. Finally, the vast majority of women academics remained unmarried.

460 Of the eight women mentioned in table 2, only three was married. Sofie Rostrup and Bodil Jerslev
 461 both had children while working as academics, while Anna Hude left her ~~academic~~ position at the
 462 Danish National Archive to ~~marry~~ late in life. Inge Lehmann's background and experience precisely
 463 fit in Rosenbeck's (2014) generalization of female academics of the period: she came from an
 464 intellectual family, her grades were above average, she took longer to finish her studies than the
 465 male students, and ~~she~~ remained unmarried.

466

467 American historian of science, Margaret Rossiter, in her cardinal work *Women Scientists in*
 468 *America* (1984) points out that many women turned to the "Madame Curie strategy": instead of
 469 addressing imbedded inequality in the workplace, women often internalized their struggle. Wanting
 470 to prove their ~~entitlement to~~ right to practice science, they tried to surpass ~~their~~ male
 471 scientist ~~colleagues'~~ scientific achievements. As a result, some women drove themselves to
 472 exhaustion or nervous breakdowns in their quest for academic excellence. Margaret Rossiter's
 473 studies were based on the ~~condition~~ s of women in the US, but many of the patterns she observed
 474 can reasonably be applied to the situations of Danish female academics. Evidently ~~in 1911~~, Inge
 475 Lehmann ~~displayed~~ experienced a stressed-related breakdowns in 1911 due to overexertion, a
 476 pattern of behavior analogous to Margaret Rossiter's observations about women's self-inflicted
 477 overcompensation. It is worth noting that the new material presented in this article ~~strongly~~ calls into
 478 question the severity of Inge Lehmann's breakdown, and suggests that it's ~~suggesting that the~~
 479 allegedly devastating impact on her psyche more likely ~~was the result of~~ reflected society's ~~self-~~

480 fulfilling prophesy about the fragility of the female intellect. Not surprisingly, intellectual insecurity
481 was a common feature among contemporary female scientists. In 1890, Anna Hude had to leave
482 her position as the National Archive's first female historian after only a year due to nerves. She was
483 rehired the following year. When German physicist Lise Meitner lectured at Niels Bohr's Institute
484 for Theoretical Physics in 1922 she confided to Bohr's wife that she was enormously reassured to
485 know that he valued her work, for it helped her overcome the insecurity that sometimes afflicted
486 her. (Sime 1997). At that time, by then Lise Meitner had published over forty papers and
487 discovered protactinium.

488
489
490
491 Margaret Rossiter has observed that the prospects for promotion of women scientists
492 in fact, of the eight trailblazing women in Table 2 only the youngest four (Julie Marie Vinter
493 Hansen, Astrid Friis, Bodil Jerslev, and Eli Fischer-Jørgensen) was able to get obtained university
494 positions at university, while the others rest were as employed in mostly positions that related to
495 their disciplines.

496
497 Lehmann's appointment as Director of the Department of Seismology can also be interpreted from a
498 gendered perspective similar to the cynical versatility Rossiter observed among female scientists in
499 US industry. Niels Erik Nørlund's selection of Lehmann to manage the seismological stations was
500 likely due to several factors in addition to her scientific qualifications. Firstly, there was no tradition
501 of seismological research in Denmark, so this particular research area was not prestigious.
502 Secondly, due to seismology's obscure status, there were no male candidates. Career prospects
503 were limited in a country where earthquakes are extremely rare. Thirdly, the new job's
504 responsibilities were mainly administrative and the Department's research was not connected to the
505 University of Copenhagen.

506 Nevertheless, some of the above mechanisms worked in Inge Lehmann's favor. By switching from
507 mathematics to seismology and accepting a job outside the University, she secured a permanent
508 appointment and realized her ambition of holding a senior scientific post at a time when few faculty
509 positions for women were extremely rare.

511 To a ~~modern~~ 21st-century audience. Inge Lehmann experiences illustrate how gendered perceptions of
 512 science, however well-meaning or seemingly rooted in fact, become self-fulfilling prophecies. If we
 513 want to learn from exceptional individuals, we ~~also~~ need to look at their failures as well as successes,
 514 and at the social mechanisms surrounding science. The long-term impact of the Inge Lehmann
 515 Program on gender composition in Danish research is yet unknown, but ~~the program~~ it is a one way of pushing
 516 past such social mechanisms.

519 8. Conclusion

520 Among seismologists, Inge Lehmann is remembered for her uncompromising, sometimes
 521 undiplomatic ways and as the recipient of many honors (Bolt and Hjortenber, 1994). Despite her
 522 successful international career, a close study of ~~Inge Lehmann's~~ academic experiences ~~until~~ before
 523 she became a seismologist reveals that she also faced limitations. Gender bias ~~legislation,~~
 524 employment restrictions and society's perception of ~~the~~ female biology ~~negatively~~
 525 ~~affected~~ effectively limited her career options.

526 ~~Among seismologists, Inge Lehmann is remembered for her uncompromising, sometimes~~
 527 ~~undiplomatic ways (Bolt and Hjortenber, 1994). But as a young woman, she was ambitious and~~
 528 ~~adventurous, eager to experience life beyond Denmark. In becoming a scientist, her path was not~~
 529 ~~straight forward. As a female she had to overcome society's general belief that women were~~
 530 ~~biologically unsuited to academic studies, let alone a scientific careers. She even had to overcome~~
 531 ~~her father's belief that, while intellectual gifted, she was mentally and physically unfit for academic~~
 532 ~~studies.~~

534 In her work as an actuary and as in ~~her~~ research assistant ~~job,~~ Inge Lehmann found herself in a
 535 disagreeably inferior position compared to her male colleagues. When she changed her research
 536 field from mathematics to the less prestigious seismology, she displayed a pragmatism that found
 537 hope in what was possible, and made the best of ~~By~~ performing well within a variety of narrow
 538 parameters, she made the best of things in order (~~only conducting research in her spare time, for~~
 539 ~~example) in order~~ to move up the career ladder.

540 Inge Lehmann had a career in science because at decisive moments she conformed to social and,
 541 professional and political agendas – and because she was an exceptional talented scientist.

543

544 **Disclaimer**

545 This paper is a revised version, with new data of Jacobsen (2015).

546

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