The Invisible Light
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The BIR at 125 Years.

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Contents.

Editorial.

It's been a busy time in the world of radiology history since the last appearance of this publication.

UKIO.

We had an excellent time a UKIO in Liverpool earlier this year. It was good to be back in person, since the purpose of meetings is essentially to meet people. Liverpool is important in the history of radiology, not least because of the work of the great Charles Thurstan Holland, the pioneer radiologist. I visited his house and consulting rooms which is near the Anglican cathedral in Rodney Street. The papers presented at the session were interesting, and deserved a larger audience. Elizabeth Beckmann, the retiring Chairperson of BSHR, chaired the session. Arpan K Banerjee spoke on *A history of PET-CT in the UK*. Edwin Aird gave a presentation on *L.H Gray (Physicist and Radiobiologist): His life (1905-1965), laboratory (1957-2008) and legacy*. Our new Chairperson Michael Jackson was *Exploring the equilateral: Why are medical images rectangular?* I spoke on *Neuroradiology and philology as presented in The Doctor is Sick of 1960 by Anthony Burgess*. I always find the interaction between science and culture of interest. The session was certainly varied in topics!

YouTube.

I am always pleased by the amount of interesting material on YouTube related to physics and radiology. Two excellent channels are those of Kathy Joseph and Sabine Hossenfelder, and both have written interesting books described later. Kathy's book is a brilliant introduction to the

development of ideas related to electricity, and Sabine has a more philosophical approach. Both are worth exploring.

Jean Guy and Derek Guttery.

I am reprinting a piece by the late Jean Margaret Guy MD, FRCR, DHMSA (1941-2012). Her untimely death was a great loss to the radiology history world. The article is taken from her MD thesis which she gave to me. I will reproduce more in later issues.

The late Derek Guttery made large contributions to the history of radiology, and was of significant help to the British Institute of Radiology. He collected catalogues related to the X-ray industry and had an encyclopaedic knowledge of that area. It was Derek who encouraged my interest in philatelic aspects of radiology, and also in ephemera.

BSHR Annual Lecture.

Our annual lecture is to be held at the Governors Hall at St Thomas' Hospital at 7pm on 6 February 2023, following our AGM. The speaker is Geoff Meggitt who is speaking on Hermann Mueller and entitled "Radiation, Radicalism & Race. The Science and Politics of Herman Muller." For free tickets please contact Dr. Arpan Banerjee at his email of arpankb007@gmail.com ,

The talk is based on his excellent book "Genes, Flies, Bombs, and a Better Life: In the Footsteps of Hermann Muller" of 2016 (Pitchpole Books). As the blurb emphasises, the mysteries of heredity began to succumb to science in the late 19th and early 20th centuries. A key step was the adoption of the fruit fly as an experimental subject and the discovery by Hermann Muller that nuclear radiation causes mutations. These led to maps being made of the fly's chromosomes as a chain of genes. Muller's career was nearly finished by his socialist views and he exiled himself to Germany and then Russia. He left Russia in 1937 and after a period in Edinburgh returned to the USA, where he found it difficult to obtain an academic post. Muller warned of the genetic hazards of radiation, particularly atomic weapons fallout, when this was officially unwelcome. He also promoted eugenics - racial improvement - right up to his death. This book is not just a brief biography of Muller but a history of how the ideas he inherited, supported and originated subsequently evolved and flowered or foundered.

HMES.

The Historical Medical Equipment Society (HMES) is again meeting in person post COVID. There is much of interest for those in the radiological sciences. The meeting will be held at the British Cardiovascular Society's headquarters in Fitzroy Square on 21 April 2023. The BCS celebrates its 100th anniversary in 2022 and houses a good collection of historical objects, see: http://www.bcsmuseum.org/about-bcs-museum/. The topics include myself on 'Electrotherapy, clinical & popular', Margaret Wilson on 'Light and related devices in dentistry', Neil Handley on 'Why do medical bodies establish historical museums?' and Steve Bacon on 'Perkins tractors'.

Members attend free (with a charge of £10 for guests). If you are interested please contact me.

Other Societies.

Other societies meeting next year that might be worth attending, and possibly presenting at, include the *UKIO 2023 - Synergy and symbiosis: Breaking down barriers in healthcare*, which will take place on 5-7 June at the ACC Liverpool, the British Society for the History of Medicine (BSHM) which is meeting in Cardiff, and International Society for the History of Radiology (ISHRAD) which will be meeting in Germany in Lennep.

Please send me material for the next issue. It's amusing that past issues are now on e-bay. And so for sale is "The Invisible Light No 22 Nov 2004 Journal British Society for Radiology

History" and described as "Flexi Bound this is in very good clean intact condition. The competitive price includes the postage".

Adrian Thomas
adrian.thomas@btinternet.com

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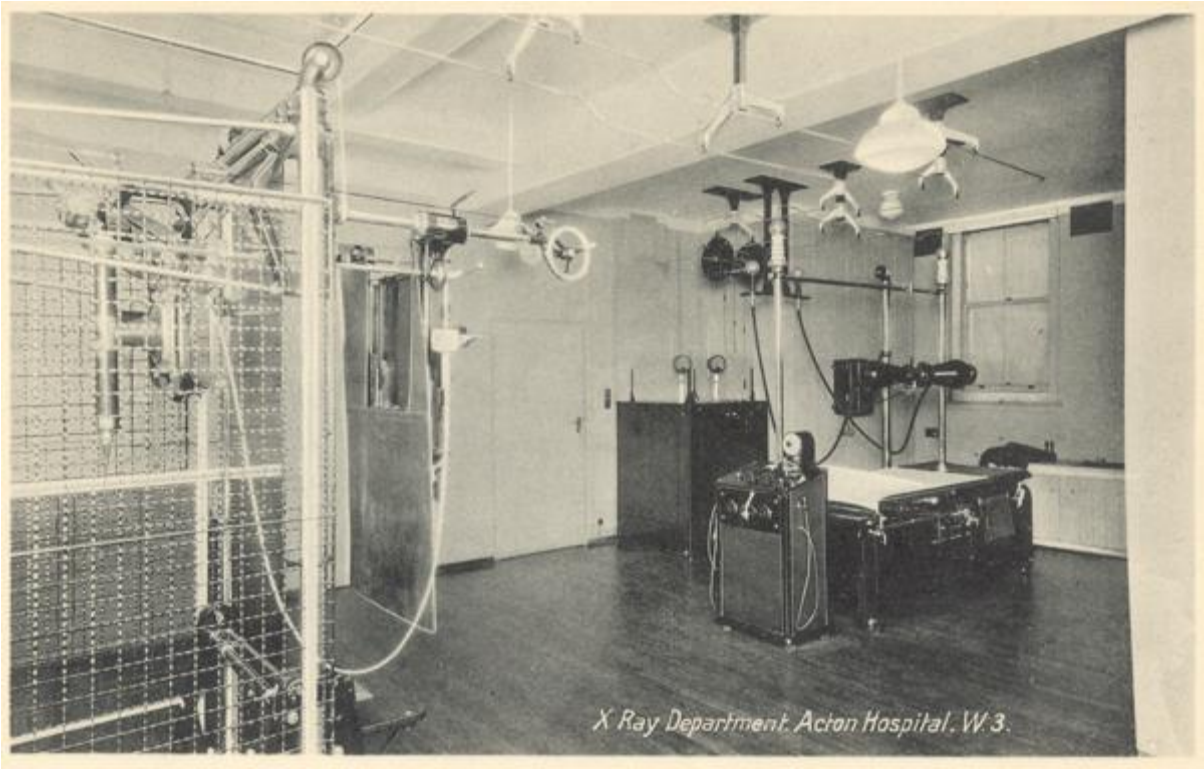
The X-ray Department at Acton Hospital.



This is a charming postcard of the X-ray department at Acton Hospital in West London. Postcards are a wonderful resource, and show images not available elsewhere. There are a surprisingly large number of postcards depicting X-ray departments. These were presumably bought from the hospital shop to allow the patients to communicate before the days of telephones, either portable on a trolley, or mobile as a mobile phone.
The postcard shows a pre-shockproof department with overhead cables to carry the HT current, with the tube for fluoroscopy seen in a cage on the left. The X-ray tubes are protected from radiation and beam-limiting cones are seen. The simple intensifying screens are seen in this time before image intensification.

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The British Institute of Radiology (BIR) at 125 Years.

By Adrian Thomas, Honorary Historian, BIR.

It's been a privilege to be involved in thew celebrations of the 125th anniversary of the Institute. The front cover shows the BIRthday cake of the Institute. The BIR is a very special – and quite an unusual society. The history of the Institute essentially begins when the news of Röntgen's discovery reached Britain on 6 January 1896.

A meeting was held on 18 March 1897 at the house of the Medical Defence Union to start a new society to study the X-rays. It was decided that membership should "include all who are interested in the scientific study of the Röntgen Rays", and this decision was to prove crucial to the ethos of the organisation. A second meeting took place on 2 April 1897 and an advertisement appeared in the British Medical Journal on 10 April. The first general meeting was held on 3 June 1897 at the Medical Society of London in Chandos Street and the inaugural meeting was held on the 5 November 1897 in the old St Martin's Town Hall with Silvanus P Thompson as the first President.

The name 'The X-Ray Society' was changed to 'The Röntgen Society' and the stand alone journal *Archives of Clinical Skiagraphy* was adopted by the Society to become *The Archives of the Roentgen Ray*. This journal, started by Sidney Rowland in May 1896, continues today as *The British Journal of Radiology*.

For a long time, the Society met at 20 Hanover Square in London. In 1911, the Society moved to the Institution of Electrical Engineers' offices and towards the end of the Great War moved again to the offices of the Royal Society of Arts. The period during and after the Great War was not an easy time for scientific societies and there was considerable financial stress; however, the Society kept up a full programme of Thursday evening meetings in London throughout the year.

The concept of a radiological institute had been first suggested in 1906 - and was revived again in 1917. The British Association for the Advancement of Radiology and Physiotherapy (BARP) was founded in 1917 and the Diploma in Medical Radiology and Electrotherapy (DMRE) was set-up at the University of Cambridge.

The BARP formed an institute in 1924 with broad aims, including providing a meeting place for those interested in radiology, providing information of all kinds and having an international influence. Part of the reason for having a physical home was to house a reference library and a museum of radiographic films and lantern slides, and so the house in Welbeck Street was acquired.

The modern Institute was created in 1927 as an amalgamation of the Röntgen Society and the British Institute of Radiology. Many had worked hard for a long time to enable this merger to come about.

The BIR moved into a new house in Portland Place in 1982 and on 11 February of that year Her Majesty the Queen graciously visited us to open the house. We had moved to Portland Place from 32 Welbeck Street W1, which had been our home since 1922. The time at Welbeck Street had been very happy and it was the centre of British radiology.

The BIR past-President, Roger Berry, has said the Institute "was multidisciplinary at its core". The BIR had only ever leased Welbeck Street for limited terms, and it might have appeared to

lack a permanent home. The Institute had been saving to purchase the lease; however, the huge increase in property values in post-war London had made this untenable. The Royal College of Radiologists (RCR) had moved to Portland Place and so by moving next door the desire was to unite the medical and multidisciplinary. Both the RCR and BIR have now left Portland Place.

From the very beginning, the three pillars of the Institute have been:

- Meetings (education).
- Publications (research).
- Library.

However, the nature of these pillars is now radically different from those of the last century for a variety of reasons. For the Institute to have a successful future, the nature of meetings, publications and library have changed It will be seen that as an organisation we will now resemble more how we were in the early 20th century. Meetings are held in a variety of physical locations in the UK, meetings can be virtual. The journal BJR is now on line, and the past issues have been digitised providing an invaluable resource.

The Institute has had many changes during its long history and we will continue to change to meet the contemporary needs of our members. There is no one fixed model as to how we serve our members. The history of the institute is the history of radiology.

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Recent Publications.

The Lightning Tamers: True Stories of the Dreamers and Schemers Who Harnessed Electricity and Transformed Our World.
Kathy Joseph
ASIN : B0B14KL4B7
Publisher : Smart Science Press (12 Oct. 2022)
This is a fascinating book on the invention and evolution of electricity. Kathy Joseph, physicist and educator, is the creator of the popular *Kathy Loves Physics* documentary channel on YouTube. The book details the story of electricity through the linked breakthroughs of men and women in science. It's a journey over 400 years of history "to discover for yourself the unlikely yet true stories of the characters who paved the way for modern electricity" and is an entertaining read and warmly recommended.

Existential Physics: A Scientist's Guide to Life's Biggest Questions
Sabine Hossenfelder
ASIN : B09T2PYC4H
Publisher : Atlantic Books (18 Aug. 2022)
Do we have free will? Is the universe compatible with God? Do we live in a computer simulation? Does the universe think?
The author notes that physicists are great at complicated research, but they are less good at telling us why it matters. Sabine Hossenfelder tells us why we should care, using the latest research in quantum mechanics, black holes, string theory and particle physics. She explains what modern physics can tell us about the big questions.
The book is written in a popular style, and is recommended, as is her YouTube channel 'Science Without the Gobbledygook.'

Paul Langevin (1872-1946): The Father of Ultrasonics.
F A Duck, A M K Thomas. Medical Physics International, vol.10, No.1, 2022, pp84-91.
In 2022 we celebrate the 150th anniversary of the birth of Paul Langevin. In 1917, Langevin invented the first piezoelectric ultrasound transducer which was used to detect U-boats. This discovery opened the way for new scientific and practical investigations. There is little biographical material in English and this is a very welcome addition to the literature. This article presents a translation of the obituary of Langevin by Frédéric Joliot- Curie, that first was published by the Royal Society of London in 1951.

Paul Langevin: The Father of Ultrasound.
Francis Duck. IPEM Scope, vol.32, Issue.1, Spring 2022, pp24-27.
An interesting article on the French physicist to celebrate the 150th anniversary of his death. The illustrations are excellent.
IPEM Scope is to be congratulated in publishing so many interesting historical articles.

Review Article: Milestones in dosimetry for nuclear medicine therapy.
J. Gear. Milestones in dosimetry for nuclear medicine therapy. Br J Radiol (2022) 10.1259/bjr.20220056.
Jonathan Gear has written an interesting paper on Nuclear Medicine therapy. He notes that to inform the future direction of this field, it is useful to reflect on the scientific and technological advances that have occurred since those early uses. He explores how dosimetry has evolved over the years and discusses why such initiatives were conceived and the importance of maintaining standards within clinical practise. Specific milestones and landmark publications are highlighted and a thematic review and significant outcomes during each decade are presented. This is a very useful and thoughtful review.

Max von Laue: Intrepid and True: A Biography of the Physics Nobel Laureate (Springer Biographies).
by Jost Lemmerich (Author), Ann M. Hentschel (Translator)
Publisher : Springer; 1st ed. 2022 edition (5 May 2022)
ISBN-10 : 3030946983
ISBN-13 : 978-3030946982
Reviewed by Adrian Thomas.
Jost Lemmerich has done us a favour by providing us with the first biography of a remarkable man. Prior to this there has been little available in English.
Max von Laue (1879-1960) was a Lecturer (Privatdozent) at the Institute of Theoretical Physics of Munich University. In 1911 Paul Peter Ewald from Sommerfeld's Institute in Munich was studying the propagation of electromagnetic radiation in a space lattice. Ewald had proposed a resonator model for crystals, however the model could not be tested using visible light, since the wavelength of light was larger than the spacing between the resonators. It occurred to Max von Laue that X-rays might have a wavelength which was of a similar order of magnitude to the spacing in crystals and that they could therefore be used to test the model. If the wavelength of X-rays were many times shorter than that of light then that would also explain the previous failures to produce diffraction effects using gratings that were only suitable for visible light. In May 1912 von Laue passed a fine pencil beam of X-rays through a copper sulphate crystal and recorded the diffraction pattern on a photographic plate. The resulting photographic plate showed a large number of well-defined spots, which were arranged in intersecting circles around the central beam. The results were confirmed by Walter Friedrich and Paul Knipping. Max von Laue then went on to develop a law that connected the scattering angles and the size and orientation of the spacings in the crystal, and for this he was justly awarded the Nobel Prize for Physics in 1914.

Max von Laue's discovery proved that X-rays were electromagnetic waves and that they were of a short wavelength. Thanks to diffraction studies it became possible to measure the wavelength of X-rays and also to the study of the inner structure of materials. The work of von Laue was taken up by William Henry Bragg (the father) and William Lawrence Bragg (his son) at Leeds in England, and they both did important work on X-ray crystallography. In 1912–1913, William Lawrence Bragg developed Bragg's law, which connected the observed scattering with reflections from evenly spaced planes within a crystal. The Braggs both shared the 1915 Nobel Prize for Physics for their work on crystallography. The earliest structures to be examined were of necessity simple in nature and showed a one-dimensional symmetry. The structure of common table salt was determined in 1914. As computational and experimental methods improved over the following decades, it became possible to examine ever more complex material. This work resulted in the study of protein structure and then spectacularly to the determination of the double-helical structure of DNA.

The work of Max von Laue on diffraction gave solid evidence that X-rays were waves of electromagnetic radiation; however X-rays also behave like particles because they can ionise gasses. Indeed it was this property of X-rays to ionising gasses that caused William Henry Bragg to argue in 1907 that X-rays were not electromagnetic radiation at all, a view that seems rather curious to us now. We now know that X-rays consist of photons and as such show characteristics of both particles and waves. The idea of the photon had been proposed by Albert Einstein in 1905, however it was not until 1922, when Arthur Compton demonstrated the scattering of X-rays from electrons, that the theory was completely accepted.

The International Union of Crystallography has published *Development of a Physicist An Autobiography* by Max van Laue, which is an extract from *50 Years of X-ray Diffraction*, edited by P. P. Ewald, and can be found at:
https://www.iucr.org/__data/assets/pdf_file/0016/745/von_laue.pdf

The Society of Radiographers: 100 Years 1920-2020.
Richard Price and Audrey Paterson
London: Society and College of Radiographers, 2021.
Reviewed by Adrian Thomas.
Richard Price and Audrey Paterson have performed a great service in writing what is now the definitive history of the Society of Radiographers (SoR). The SoR was founded in 1920 and is one of the oldest radiographic organisations in the world. The book was commissioned for the centenary of the Society in 2020, and tells the remarkable story from the beginnings to its maturity. There are two previous histories of the SoR, written by Michael Jordan (Jordan, 1995), and Ian Moodie (Moodie, 1970). Both of these earlier books are interesting and now serve to supplement this new publication. Michael Jordan's book is particularly interesting since he was working at the SoR for 32 years from 1960 finally serving as Chief Executive and General Secretary.

This new history of the SoR is well told in an interesting and engaging manner. The authors have delved deeply into the archives and have provided us with material that was previously either inaccessible or difficult to access. The book is profusely illustrated with many images in colour, and is presented in an approachable and informative manner. I particularly found the biographical details of great value and these are a helpful resource. What I particularly like about this book is the way letters and minutes are recorded verbatim, therefore making the book a useful historical resource. The authors also do not hesitate to discuss areas of challenge and controversy. There have been many challenges and difficulties over the years, and we cannot learn from history if the difficult parts are omitted or minimised. It should be remembered that

the book is a history of the SoR and not a history of radiography, although some of that history is recounted. There is a significant need for a history of the radiological sciences from a radiographic point of view. Most histories of the radiological sciences have been written by radiologists, and the radiographic perspective is different with specific insights.
Many society histories are rather dry in style and are therefore bought, perhaps out of a sense of duty, to be placed on the shelf but never read. This is not the case for this book, which is enjoyable to either read sequentially, or to browse at random. There is something in this book for everyone. The book is attractive and very accessible, and is warmly recommended.

Another Nobel Physics prize. A Different Maria
David Thwaites. IPEM Scope, vol.32, Issue.2, Summer 2022, pp20-23.

An accessible article on Maria Goeppert Mayer, the second woman to win a Nobel Prize in Physics, and the context of her work. David Thwaites is Professor of Medical Physics at the University of Sydney.

What is in a Name? Marie Sklodowska-Curie and Polonium.
David Thwaites. IPEM Scope, vol.32, Issue.1, Spring 2022, pp20-23.
Another interesting article on naming in the life of Marie Curie.

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Röntgen on a Trade Card.

This charming trade card shows radiography in the late 1890s. Röntgen is depicted on the left side. The X-ray tube in unprotected, both for electric shocks and radiation, and looks like a light bulb! The induction coil is in front of the operator, and the power is supplied by batteries seen on the floor on the right side.

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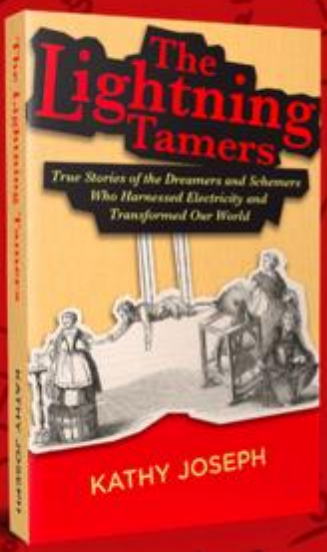
Don't Miss



The Lightning Tamers

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Invisible Light: The Remarkable Story of Radiology.
By: Adrian Thomas
Publisher : CRC Press; 1st edition (27 Mar. 2022)
ASIN : B09RVHQNR2
Reviewed by Michael Jackson, Chair of the BSHR.

Invisible light offers a highly accessible and insightful overview of the history of radiology and medical imaging.
Although ordered approximately chronologically (Chapter 1 charting the discovery of X-rays and the final chapter considering The Future) each chapter focuses on a specific theme (including less familiar topics such as Dangers in the X-ray Department, Contrast Media, Tubes Plates and Screens) such that the volume works as a series of stand alone essays which can be dipped into in isolation. Indeed, while relatively jargon-free for a book charting some highly complex technological progress, each chapter is sufficiently packed full of facts, anecdotes and commentary, that readers are likely to tackle the book on a chapter-by-chapter basis. Focusing on the Invisible Light - electromagnetic radiation outside the visible spectrum - ultrasound is not included, and nuclear medicine examinations are also not covered.

It will come as no surprise to readers of Invisible Light (the journal) that Adrian Thomas is an extremely knowledgeable guide to steer us through the journey of radiology. In addition to the expected well researched factual content charting the pivotal discoveries and their impact within science and medicine, I greatly enjoyed the broader scope of enquiry, assessing radiological concepts and their impact on popular culture and the sociological dimensions of making the body increasingly transparent. The chapter specifically considering Radiology and Culture was a particular treat for me, with a rich seam of visual-based culture to draw upon, including artwork by Urszula Zajkowska, Susan Aldworth and Hugh Turvey. The analysis of radiology within literature including The Magic Mountain by Thomas Mann (1924) and The Doctor is Sick by Anthony Burgess (1960) stands out as a highlight (the incisive analysis of Burgess also forming the basis of an excellent talk delivered at UKIO, July 2022).

Chapter 4, considering Radiology and Anatomy, also offers interesting perspectives on the broader impact of the discovery of X-rays, demonstrating how radiographs not only revealed body structures and pathology at the point of clinical need, but also provided new understanding of human anatomy and physiology. As a paediatric radiologist I found the sections discussing the fresh insights into bone development in childhood offered by X-rays to be fascinating. We are reminded that challenges and controversies related to bone age examinations remain unresolved to this day.

Thomas typically lays out relevant ancient historical precedents before getting to grips with developments in the 19th and 20th centuries. The account of the development of MRI, for example, starts with the very first observations of magnetism in lodestones (documented by Lucretius and Pliny the Elder) together with an interesting account of Mesmerism before tackling the thorny issue of priority in the development of NMR. The debate about the 2003 Nobel prize for Physiology or Medicine (awarded to Paul Lauterbur and Peter Mansfield) has been rekindled in the context of Raymond Damadian's recent passing and Thomas does well to tread through this potential minefield in what feels like an even-handed fashion.

A minor criticism is in relation to the illustrations. There are plenty of fantastic figures, many of which I have not seen before (a particular favourite being a mid-20th century prediction of what a radiology department might look like in the year 2000). However, a great deal of portrait photos are also included, the vast majority of which, in modern parlance, could be labelled as

"stale, pale and male". A casual potential reader leafing through the book could mistakenly attribute a certain stuffiness on this basis, which would certainly do the book a great disservice – Chapter 9 for example specifically examines the contribution of Women in radiology.

It is nevertheless noteworthy how many of the more recent portraits are photographs taken by the author himself, a reminder of a deep passion for radiology history sustained over many decades. The overall content of the book is anything but stuffy, peppered with numerous and diverse cultural reference points, biographical anecdotes, immersed in philosophy, political ideology and religion and informed by a wealth of knowledge. The final chapter, contemplating the future of medical imaging, weaves together these strands highly effectively, arguing that humanity and clinical judgement must be at the core of radiology if ever advancing technology is to effectively serve the needs of patients. The book concludes by reflecting on Plato's distinction between sophia (theoretical wisdom) and phronesis (practical wisdom). Both of these are to be found throughout this book, which is highly recommended.

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IOMP: The International Organization for Medical Physics.
https://www.iomp.org

This Special Issue (History of Medical Physics 7), dedicated to Medical Physics History, focusses on the IOMP History. It includes 4 articles and all IOMP History Tables (updated 2022). This issue forms a specific chapter in the IOMP History Project. It acknowledges the hundreds of colleagues from over 50 countries who took part in the activities of the International Organization for Medical Physics (IOMP) from its formation in 1963 to 2022.

http://mpijournal.org/pdf/2022-SI-07/MPI-2022-SI-07.pdf

IOMP was formed in January 1963 initially with 4 affiliated national member organizations. The Organization has a membership of 86 national member organizations, 1 affiliate and 6 regional organizations. The Organization is affiliated to IUPESM, IUPAP and ICSU and is officially connected to IFMBE. IOMP is charged with a mission to advance medical physics practice worldwide by disseminating scientific and technical information, fostering the educational and professional development of medical physics and promoting the highest quality medical services for patients. Information on IOMP activities, development priorities, and external relations are given in her strategic policy document Review and Way Forward of IOMP.

IOMP works together with International Organizations such as IAEA, WHO and ILO to strengthen the role of Medical Physicists. ILO has recently classified medical physicists as a profession in the International Standard Classification of Occupations-08 (ICSO-08) under physics and astronomy, which is an important reference document for governments for recognition and classification of occupations.

IOMP collaborates with professional bodies such as IRPA and ICRP and international organizations such as WHO and IAEA in promoting the development of medical physics and safe use of radiation and radiological equipment technology.

IOMP is collaborating with professional organizations in development of a professional certification system for medical physicists that can be implemented on a global basis. To provide guidance on education, training and professional development of medical physicists, IOMP is publishing some policy documents on such issues.

IOMP together with IFMBE and IUPESM organize the World Congress on Medical Physics and Biomedical Engineering (World Congress) once every three years. IOMP also organizes the International Congress of Medical Physics (ICMP) which is held between World Congresses. IOMP provides travel support to medical physicists from developing countries to attend these meetings.

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James William GIFFORD, 1856-1930.

A letter from 1996 written by the late Derek Guttery. Derek's son Simon gave me a copy of the contents of his father's hard drive. There is much of interest. (Ed.)

Dear …….

You may recall that I spoke to you on the telephone on 12 January concerning J.W.Gifford's involvement with X-rays immediately following the announcement of their discovery and my interest in establishing whether or not any historical material or personal knowledge relating to Gifford still survive in Chard. I also promised to send you a photograph showing Gifford working in his private laboratory together with a few notes about his involvement with X-rays.

The enquiries that I have made so far show that apart from his direction of the family business of lace-making, Gifford was also a keen amateur scientist, astronomer, skilled photographer and one-time voluntary assistant to Sir William Crookes.

Gifford was very well equipped with all the apparatus needed to generate X rays when he read an account of Röntgen's discovery in the EVENING STANDARD for 7 and 8 January. He had recently purchased a hand-driven dynamo and a powerful [Apps] induction coil for research into "spectrum photography" and also possessed a set of Crookes tubes acquired about fifteen years earlier including one with a saucer-shaped "focused" cathode and platinum-foil anti cathode.

His first attempt to produce X-rays was unsuccessful leading him to suppose that the newspaper accounts were either a hoax or a misconception and on this basis he addressed a letter to the Royal Photographic Society for its 14 January meeting detailing his experiments and their failure. However, more detailed information in later press reports caused him to make a fresh attempt and on Saturday, 18 January, 1896 he succeeded in "electrographing" his young son's hand. The exposure time was 10-15 minutes. Gifford describes the technique used in an article "Electrography; or the New Photography" published in the April 1, 1896 issue of KNOWLEDGE:

> . . . on Saturday the 18th, to my great delight, I succeeded in electrographing a child's hand through cardboard. This was shown at the Photographic Meeting on the following Tuesday. In this early experiment, and in fact in all the earlier ones, the plate was enclosed in a cardboard box, such as photographic plates are packed in, and the hand laid on the lid of the box about two inches below the glass bulb – for, as far as appearance goes, tube is a misnomer – with the result that a child's hand appeared on the plate after development. In the earlier attempts five minutes' exposure was given, and in the first successful one the nails appeared, but little or no bone. Never since the first

> experiment have the nails appeared – why is not known. Probably the bones did not appear partly because it was a child's hand and the ossification imperfect, and partly because the exposure was too short for the power used. . . .

Gifford's wife, Emma, writing from "Oaklands", Chard, recalled the event in a letter to the TIMES nearly forty years later (27 February, 1932, p.6d):

> . . . My husband took his [radiograph] at the request of my son, a boy of 10, on Saturday afternoon. I well remember the excitement when my husband came out of the dark room with the dripping negative in his hand and said "You can see the bones!"

Gifford soon discovered that he could achieve a considerable improvement in image definition by increasing the "bulb"-to-plate distance from 2 inches to 6 inches.

Further on in the article in KNOWLEDGE, Gifford explains in considerable detail the preparatory work prior to the actual exposure:

> . . . The subject to be operated on is taken into the darkroom. A sheet of celluloid or mica is laid over the film of a sensitive plate; the hand, if that is the part to be electrographed, is laid on the celluloid, and the whole enclosed in a black cloth bag, tied tightly round the wrist so that no light may get at the plate. The plate may then be taken into broad daylight - not bright sunshine - and laid with the patient's hand upon it, on a table over which the bulb [Crookes tube] is hung . . . In some experiments no celluloid was used, and in more than one case the warm moisture of the hand partially melted the gelatine [of the photographic emulsion]. In others a paper bag made of grocer's paper was slipped over the plate to prevent contact. The paper meant is the greased paper used for wrapping up butter; . . . but in some cases the grease melted, and the last of that plate was worse than the first . . .

Without question, Gifford's first successful radiograph of 18 January, 1896 was one of the very first taken in this country and only preceded in terms of priority by the very faint X-ray image of a coin exposed through a sheet of aluminum produced by the London electrical engineer A.A.Campbell Swinton on 7 January and the same experimenter's radiographs of various metal objects on 8 January and of a human hand on 13 January.

Gifford gave one of the earliest public demonstrations of X-rays in London on 21 January at the Royal Photographic Society, 12 Hanover Square and also published many articles on the subject in Nature, Knowledge and various contemporary photographic journals. Some of the radiographs illustrating his articles are the joint efforts of Mrs Gifford and a Miss Baylis. Apart from human extremities of hands, feet and the hand and forearm of "Sylvia Gifford, aged 6", typical subjects included a coiled adder, a sparrow, a mouse and a cat's paw. Other radiographs illustrating his articles are credited to Mr. C[harles] Baker, the optician and microscope maker of High Holborn, and F.Higgins, the Chard photographer. I have no doubt that all of these names are familiar to you.

The enclosed (*with the original letter*) photograph (in three copies) was taken in February 1896 by F. Higgins of Chard to accompany an article by H. Snowden Ward entitled "Marvels of the New Light: Notes on the Röntgen Rays" published in the April issue of the Windsor Magazine. It shows Gifford in his spacious home laboratory surrounded by a plethora of the apparatus needed to generate X-rays including a Crookes tube, two induction coils, a collection of Leyden jars and a hand-operated vacuum pump. Some of Gifford's other scientific interests are

indicated by a "state of the art" spectroscope and a collection of bottled chemicals clearly visible in the background.

After about 1898-99, Gifford's name disappears from the X ray scene and it is assumed that he had become bored with practical aspects of the subject and moved on to other fields of science. However, he continued his association with the [London] Röntgen Society – to which he had been elected one of the earliest members in 1897 – until at least as late as 1918. His range of interests outside the business of lace-making is shown by his Fellowship of the Royal Photographic Society (1895), Royal Astronomical Society and Royal Microscopical Society. I assume that his rank of Lieut-Colonel came from involvement with the Territorial rather than regular army.

When Gifford died in 1930 at the age of 74, his estate amounted to £148,942. He gave £4,000 in trust to the vicar of Chard and general medical practitioners of the town to support a qualified nurse for the benefit of residents. The rest of the estate was left to his family. In 1910, he had presented his personal hoard of 40 mg. of radium – then worth about £600 – to the Cancer Research Laboratories of the Middlesex Hospital.

From the many things that you mentioned during our telephone conversation, I particularly remember that the Gifford lace factory closed in about 1960 and that the building may be taken over by the local council; and that you suspect that Gifford's father, "J.B." was one of the founders of the Y.M.C.A. I was also intrigued to learn that as young schoolboy, you either attended or witnessed Gifford's funeral procession. During our conversation, I also mentioned Sir William Crookes and his long-time personal assistant, C.H. ("Charlie") Gillingham. After 'ringing-off, I thought it unusual that you seemed so familiar with both names and wondered if either or both of them also had some connection with Chard.

If you feel that there is any relevant Gifford material still surviving in Chard – or in Chard Museum – I would very much appreciate hearing about it. I would also value any comments or additions that you might wish (to) make to the notes contained in this letter. However, if you prefer not to get involved, I shall fully understand.

I very much hope that I shall hear from you.

Yours sincerely

D.R.Guttery.

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"The Development of Diagnostic Radiology in Britain 1896-1921, and factors influencing its growth".

By Jean Guy.

The following is taken from a dissertation submitted by the late Jean Margaret Guy in fulfilment of the requirements for the degree off Doctor of Medicine at the University of Cambridge in 2002. The title of the dissertation was: "The Development of Diagnostic Radiology in Britain 1896-1921, and factors influencing its growth". What follows is the introduction to the thesis, with minimal editing.

INTRODUCTION

The discovery of X-rays in 1895 was made not in Britain but in the University of Würzburg by a German physicist and engineer, Wilhelm Conrad Röntgen. The discovery and those events which led up to it, have been well documented[i] and it is not proposed to repeat the story here. The reception of the news in Britain is also well known.[ii] It led to important scientific discoveries, which are also beyond the scope of this study. The description of Röntgen's experiments made a great impact on the lay and medical press in January 1896. Much of the document's power lay in the illustration of the skeleton of Frau Röntgen's hand and the pictures of metallic objects shown through bodies opaque to visible light.[iii] These stimulated experiments by doctors and physicists alike, designed to determine whether X-rays would be useful in medicine and surgery.

The Rapid Initial Introduction of X-Rays.

The academic and medical uses of electricity had not developed independently. Until the 1850s much of the stimulus for improvement of electrical apparatus, particularly of the induction coil, had come from medical practitioners and medical instrument suppliers.[iv] Golding Bird, a physician at Guy's Hospital, had been responsible both for setting up the hospital's electrotherapy service, and for making improvements to the induction coil required for high frequency alternating current. That department fell into disuse after his death, but the one at St Bartholomew's Hospital, set up by W E Steavenson in 1882 and by 1896 run by H Lewis Jones, was thriving, as was the one in Glasgow, founded by the ENT surgeon John Macintyre.

Physicists and physicians became embroiled in the initial enthusiasm for X-ray examinations. Schuster and his assistant Arthur Stanton themselves engaged in radiography. J. J. Thomson allowed the facilities of his department at the Cavendish Laboratory to be used by patients with needles lost in the hand or fractured limbs.[v] Oliver Lodge embarked on a joint search for a metallic foreign body in a boy's hand together with Robert Jones, the pioneer orthopaedic surgeon, and Charles Thurstan Holland, a general practitioner, soon to become the first radiologist in Liverpool. Lewis Jones at St Bartholomew's Hospital and William Hedley at the London Hospital were initially enthusiastic about this branch of medicine, which they saw as a natural extension of electrotherapy and electrodiagnosis. Both soon complained that patients requesting the 'new photography' were swamping their small departments. University physics departments were not well suited to providing a clinical service, and with one exception, withdrew from this activity after a few months.[vi]

Electrical Departments did not disappear. Physicians involved in electrotherapy might, like John Macintyre, embrace X-ray technology and make it their own, while continuing their original practice. Lewis Jones, Hedley, and Hedley's successor, Reginald Morton, were primarily electrotherapists and delegated the X-ray work to technicians and junior colleagues. Apparatus was

common to both activities. Some increased their range of treatment by the later development of X-ray, radium and light therapy.

Electrotherapy had become popular in Britain as it was elsewhere in Europe and in the USA. In several of the larger hospitals, namely the Royal Infirmaries of Edinburgh and Glasgow, and in London, St Thomas's, Guy's, St Bartholomew's and the London Hospitals, departments of electrotherapy had been in existence before 1896. Patients were being treated by static and current electricity for a variety of disorders. Electricity was supplied by batteries or by induction from glass plate frictional apparatus, commonly called Wimshurst machines.

Pioneer X-ray work was not confined to hospitals and universities. Most of the physicians who practised radiology had their own apparatus. John Hall-Edwards of Birmingham gave an account of running his personal equipment for several hours a day for two weeks in his initial enthusiasm.[vii] Independent scientists, such as William Crookes, Lord Blythswood and C E S Phillips, had their own well-equipped laboratories. There were many less well-known scientific amateurs, some of whom (James Gifford in Chard, Somerset,[viii] the Revd T E Espin of Tow Law, County Durham[ix] and Revd Frederick Walter in King's Lynn, Norfolk[x]) provided a clinical service to medical practitioners in their area.[xi] Some general practitioners in cities and rural areas bought their own apparatus.[xii] There was no hard and fast distinction, however, between general and specialist practice. General practitioners used X-rays in local cottage hospitals, for example, Ellis Pearson of Bideford in Devon. This theme is developed further in Chapter 8 (*Note: of this thesis*).

By the last quarter of the nineteenth century several universities in Britain had departments of physics where experiments were in progress on the passage of electricity through a vacuum. What was required to produce X-rays was a means of generating electricity at high voltage, a laboratory technician capable of glass blowing, and a vacuum pump. With these they were able to reproduce Röntgen's experiments within days of his paper being reported. William Crookes, the independent London chemist, Lord Blythswood in his private laboratory in Renfrewshire and Herbert Jackson of King's College London had produced X-rays before 1895 without recognising them. Physicists in France, Germany, Italy and the USA were similarly equipped, and many of them, particularly in Germany, were following similar lines of research to Röntgen's own.

***Map 1* – X-Ray Experiments and Services Outside Hospitals in 1896**

Definition of Terms.

The early days of the speciality are characterised by flexibility of nomenclature that later became more rigid. The term *radiology* was little used in Britain in 1896 and was more popular in those European countries using Romance languages, coined by Béclère in that year in France as *radiologie*. The word *Roentgenology* or *Röntgenology* and its derivatives were more popular in German-speaking countries, in the USA (though not universally) and initially in Britain.[xiii,xiv] For political reasons the German name became less popular in Britain during and after the First World War.[xv] Röntgen himself described his discovery as *X-rays* and this name has survived throughout.[xvi]

In English medical literature the phenomenon was also known as *'the new light'*, and *'the invisible light',* and the end product a *cathodograph*, a *skiagraph*, an *X-ray photograph* and a *radiograph*. A gradual change in nomenclature is demonstrated by a study of the index entries in the *British Medical Journal* for the years 1896-1905. The first of the volumes specifies '*Photography*, *new', 'Radiation', 'Roentgen', 'Roentgen rays',* and *'Skiagraphy (see Roentgen)'*. In 1897 all the references are under *'Roentgen ra*ys' or are cross-referred to this heading. *'Skiagraphy*' was reintroduced in 1901 for two years, and from 1904 *'Roentgen rays'* and '*X-rays'* share the entries between them. The process of using X-rays was variously described as '*The new photography', 'skiagraphy'* and *'radiography'.*[xvii]

Its practitioners in Britain were rarely called *radiologists* during the first years of the period of this study. Dr A L Gray of Richmond, Virginia, USA, who began X-ray work in 1902, limited his practice to radiology from 1908 and then became one of a small group of physicians who called themselves *radiologists.* [xviii] That term is now used for doctors using radiology for treatment or

diagnosis. However in Britain there were few practitioners in a position to devote the whole of their time to the speciality until after the First World War.[xix]

The medical specialist was more commonly called a *radiographer*, often given the title of *medical electrician, medical photographer,* or *honorary medical radiographer* in official hospital minutes. As medical radiological practice became busier, the hospitals were obliged to appoint non-medical assistants; from 1920 onwards it was this group who were known as *radiographers*. For the purposes of this study medical practitioners of the science of radiology will be called *radiologists*, except when quoting their titles from the original documents, and non-medical practitioners *radiographers* in accordance with modern practice and to avoid confusion.[xx]

Until the Second World War most radiologists used X-rays and radium in treatment as well as diagnosis. Since then diagnosis and treatment have become separate specialities. Although the radiologist during the era discussed here regarded therapy as an integral part of his or her work, a detailed discussion of X-rays as treatment falls outside the scope of this thesis. Many pioneer radiologists had been using electricity for medical diagnosis and treatment. When X-rays were first described these practitioners took on radiodiagnosis and treatment with enthusiasm, in addition to their former practice.[xxi] For this reason many early departments of radiology were known as *Electrical Departments* or *Electrical Pavilions*, and the speciality was known from time to time as *Medical electricity and radiology* or simply *electrology*. Part of that practice has been incorporated into the speciality now known as *physiotherapy*. Chapter 8 on professional development explores these themes in more detail.

The variant spellings Röntgen and Roentgen are both used in this thesis, according to their original orthography, for example, the journal *Archives of the Roentgen Ray* and the *Journal of the Röntgen Society*.

The purpose of this thesis is to demonstrate how the early experiments with X-rays led to the establishment in Britain of a new modality of medical investigation. Although similar events took place in most of the developed countries of the world during this first quarter century, each country had its own perceptions of the potential of the discovery and the changes needed to develop it. Several chronological accounts of radiology's development have been published relating to Britain, North America and Europe, but with little discussion of the factors influencing the development of techniques, institutions and professions.[xxii]

Fundamental to this study is the late Dr E H Burrows' text, *Pioneers and Early Years, A History of British Radiology*.[xxiii] This comprehensive study of the first thirty years provided a chronological and geographical starting point for the arguments developed here. In the space available it is not possible to make a cross-national comparative study. It is to be hoped, though, that more extensive studies will be made in other countries, enabling international comparisons to be made.

The first twenty-five years of radiology in Britain are characterized by diversity of provision gradually becoming an orderly pattern. X-rays were produced in universities, doctors' surgeries, hospitals, chemists' premises and electricians' consulting rooms. Initially, the apparatus was locally and individually made to a variety of designs, was low in output, fragile and unpredictable, later becoming larger, more complex, robust and controllable. The operators of the equipment and at first the interpreters of the image were not exclusively medical, and in the years prior to 1900, medical 'radiographers' were probably in the minority. The later pattern of non-medical operators and medical interpreters had only begun to emerge by 1921.

Hospital X-ray services started in 1896 with small and simple apparatus in the humblest possible surroundings. By 1921 most major hospitals in British towns and cities had X-ray departments of one or more rooms, usually with a full-time lay operator, and some even had a medical radiologist on the hospital board. Most had made some provision for the protection of patient and operator from the unwanted effects of radiation. However, money was not readily available for a radiographic service, already seen as an expensive technology, and some traditionalist hospital doctors were unwilling to make provision for a specialist technique or the specialist doctors providing it.

This thesis examines early diversity, later developments and the processes by which changes were brought about.

An initial detailed survey was made of unpublished documents in hospital and county archives to show the development of X-ray services in hospitals in the South-West of England, namely, Cornwall, Devon, Somerset, Gloucestershire, and the cities of Bristol and Bath. It is possible in this small geographical compass to examine all the surviving documents relating to hospital administration, to identify the individuals involved and to establish the pattern of provision over the first twenty-five years of radiological history.

Using printed material, supplemented with detailed studies of selected hospitals in London and in towns and cities outside, London and other parts of Britain are compared with the South-West.

Subsequent chapters examine factors unrelated to locality which influenced growth. These are the appreciation of the harmful effects of radiation and the means taken to combat it, the growth of the medical and non-medical professions involved in radiology, the changes in equipment, and the effect of war.

SOURCES

The South-West of England

Information has been obtained from manuscript hospital minute books and reports, from printed annual reports in newspapers, brochures and bound volumes, from printed hospital histories, and from personal reminiscences, where these are relevant to the period in question. These records were found in the appropriate county and city record offices, in Gloucester, Bristol, Taunton, Exeter, Plymouth and Truro; in the hospitals themselves, particularly at Bath, Stroud, Yeovil and Newton Abbot; and in the local studies sections of public libraries, especially those of Taunton, Yeovil and Barnstaple. Many records were incomplete, particularly for the smaller hospitals, from accidental loss or as a result of deliberate destruction, some on the introduction of the health service in 1948, and some when moving into a new hospital, particularly in the 1970s.[xxiv,xxv] A useful check-list of hospitals for this study in the South-West of England is provided in the Ministry of Health's *Hospital Survey - The Hospital Services of the South Western Area* of 1938.[xxvi]

The *Survey* summarizes in tabulated form those acute hospitals having X-ray facilities then, adding to its list of voluntary general hospitals the larger municipal hospitals with better facilities. Such hospitals number twenty-seven in Bristol, Bath and Gloucestershire, with twenty having X-ray facilities. Of the eighteen listed hospitals in Somerset, six have X-rays. Thirty-three hospitals are listed for Exeter, Plymouth and Devon, nineteen having X-ray sets, and of sixteen hospitals in Cornwall nine are so equipped. Thus fifty-four of the ninety-four general hospitals in the South-West of England possessed radiological equipment by 1938 (Table 1).

Table 1 - Hospitals in the South-West of England

Hospital	X-rays in 1938	Records	X-rays by 1921
Axminster Cottage	+		
Bath, Lansdown Hosp & Nurs. Home	+	-	
Bath, Royal National. Hosp. for Rheumatic Diseases [Royal Mineral Water Hospital]	+	+	+
Bideford	+	+	-
Bridgwater & District	+	+	+
Bristol General Hospital	+	+	+
Bristol Homeopathic	+		
Bristol Royal Infirmary	+	+	+
Bristol, Cossham Memorial Hosp.	+		
Bristol, Hospital for Sick Children & Women	+		+
Bristol, Southmead General Hosp.	+		
Bristol, Winford Orthopaedic	+		
Brixham	+		
Camborne-Redruth Miners' & General	+	+	+
Cheltenham General & Eye	+	+	+
Cirencester Memorial	+	+	+
City General Hospital	+	-	
Dawlish	+	+	?
Dilke Memorial Hosp Cinderford	+	+	-
East Cornwall H, Bodmin	+		
Exeter	+		
Exmouth	+	+	+
Falmouth	+		
Frome Victoria	-	+	+
Gloucestershire Royal Infirmary	+	+	+
Launceston	+	+	-
Minehead & East Somerset	+	+	
Moore Cottage Bourton-on-the-Water	+	-	-
Moreton-in-Marsh District	+	+	+

Newton Abbot	+	+	+
North Devon, Barnstaple	+	+	+
Paignton & District	+		
Passmore Edwards, Liskeard	+	+	-
Plymouth City General	+		
Prince of Wales , Greenbank [South Devon & East Cornwall]	+	+	+
Prince of Wales, Devonport	+		
Prince of Wales, Lockyer St. Homoeopathic	+	+	-
Royal Cornwall Hospital, Truro	+	+	+
Royal Devon & Exeter	+	+	+
Royal United Hospital Bath	+	+	+
Shepton Mallet District	+	+	
St Michael's, Hayle	+	+	?
Stroud General	+	+	+
Taunton & Somerset	+	+	+
Tavistock	+		
Teignmouth	+	+	-
Tetbury & District	+	+	-
Tewkesbury	+	+	-
Tiverton	+	+	-
Torbay Hospital, Torquay	+	+	+
Tyrell Cottage H., Ilfracombe	+	+	-
West Cornwall H., Penzance	+	+	+
Weston-Super-Mare General	+		
Yeovil District	+	+	+

In the left hand column are all those hospitals which are listed in the 1945 Hospital Survey ["The Domesday Book"] for the South West of England, which are known to have had X-ray facilities either in 1921 [column 4] or at the time of the survey [column 2]. For many of these hospitals, no records survive for the period of this study [column 3].

Total number of hospitals listed in 1938 in south-west England: [excluding Wiltshire] including isolation hospitals and convalescent homes 211
Those which possessed X-ray facilities in 1938 44
Those which possessed X-ray facilities in 1921 23

The records held by public institutions (record offices, libraries and hospitals) for this period are incomplete in geographical and historical terms. This investigation revealed records of forty-three of those ninety-four hospitals for the survey period, twenty-one of which had radiological equipment installed before 1921. One hospital, the Victoria Hospital in Frome, had the equipment in 1897 but not in 1938.

London Hospitals

There was no attempt to make this part of the survey comprehensive. Unpublished material was consulted in the archive of the London Hospital, now the Royal London Hospital; the archives of the Middlesex Hospital, the Royal Free Hospital and London School of Medicine for Women, also retained on their hospital sites; and the Greater London Record Office, with reference to Guy's, Westminster, St Thomas's, St Mary's and Paddington Children's Hospital. Several hospitals and medical schools produced their own reports and Gazettes, which described recent developments and sometimes lectures given. Helpful information was found in those of the London, St Thomas's, Guy's, St Bartholomew's, St Mary's, St George's, Charing Cross and the London School of Medicine for Women.

There are published hospital histories for the London Hospital and for its medical college, Middlesex Hospital, Middlesex Medical School, University College Hospital and Medical School, St Bartholomew's, St George's, Guy's, Charing Cross and its Medical School, University College Hospital and Medical School, the Royal Northern Hospital, Holloway, the Central Middlesex Hospital, the Royal National Orthopaedic Hospital, and Moorfields Eye Hospital. The references to X-ray departments in such books tend to be brief. Reports were also found in the national medical and radiological journals, as listed in the Bibliography.

Beyond London: English Provinces, Wales, Scotland and Ireland.

The whole of Ireland was then part of the United Kingdom. Unpublished records were sought in the city and county record offices, reference libraries and in health service archives in Cardiff, Cwmbran, Aberystwyth, Liverpool, Newcastle upon Tyne, Oxford, and Birmingham. Published hospital histories were extensively consulted.[xxvii]

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[i] Glasser O. *Dr W C Röntgen.* Springfield, Illinois: Charles C Thomas 2nd ed. 1958; 33-52.

[ii] Burrows EH. *Pioneers and Early Years: A History of British Radiology.* St Anne's, Alderney, C.I: Colophon 1986.

[iii] Röntgen WC. On a new kind of rays. *Nature* 23 Jan 1896; 53: 274-276.

[iv] Hackmann W. The induction coil in medicine and physics 1835–1865. In Blondel C *et al. Studies in the History of Scientific Instruments*. London: Rogers Turner Books Ltd. 1989; 235-50.

[v] Thomson GP. *J. J. Thomson and the Cavendish Laboratory in his Day*. London: Nelson 1964; 94-5.

[vi] Williamson R. Arthur Schuster, a pioneer in physics teaching. *Manchester Memoirs* 1988-9; 128: 31-45, see p 38; the exception was the physics department in Aberystwyth.

[vii] Anon. "The Röntgen Rays" A new set of rays. *Photography* 19 Mar 1896: 200.

[viii] Obituary: Colonel James William Gifford. *Proceedings of the Somerset Archaeological and Natural History Society* 1931; 76: 107-8; Burrows EH. *Op cit:* 41-2.

[ix] Kronenberger FL. The medical activities of the late Reverend T H E C Espin, vicar of Tow Law, against the background of contemporary medicine. *Newcastle Medical Journal* 1964; 28: 174-6.

[x] Walter FW. Letter to the editor. *J Röntgen Soc* 1906-7; 3: 24 and plate II, a and b.

[xi] See Burrows EH for Crookes, C E S Phillips, Blythswood, & Walter: 4-5, 27-8, 31, 43.

[xii] Burrows cites Dr Charles Savory of Haverfordwest, Pembrokeshire: 42, and George Rodman and George Batten of London: 173-4.

[xiii] For an extensive discussion of the semantics of the subject see Grigg ERN. *The Trail of the Invisible Light: from X-strahlen to Radio(bio)logy.* Springfield Illinois: Charles C Thomas 1965; 167-274.

[xiv] Pancoast HK, Failla G, Watkins WW. Terms used in Radiology. *Journal of the American Medical Association* 29 Sept 1928; 91**:** 960-1.

[xv] *ARE* 1915-16; 20: 1-2.

[xvi] Glasser O. *Op cit.*

[xvii] A general practitioner in Sherborne, Dorset, who retired in the 1970s was still in the habit of writing 'ski' when requesting a radiograph.

[xviii] Barnes C. A Tribute to a Pioneer Radiologist: Alfred Leftwich Gray, MD (1873-1932). *AJR* 1988; 150: 11-12.

[xix] Barclay AE. The passing of the Cambridge Diploma. *BJR* 1942; 15: 351-4; *idem* Early days of radiology in Manchester. *Manchester University Medical School Gazette* 1948: 115-21 [p 121].

[xx] The Society of Radiographers. *ARE* 1920-21; 25: 247.

[xxi] Barclay AE. The passing of the Cambridge Diploma.

[xxii] Bruwer AJ. *Classic Descriptions in Diagnostic Roentgenology*. 2 vols. Springfield Illinois: Charles C Thomas 1964; Grigg ERN. *The Trail of the Invisible Light: From X-strahlen to Radio(bio)logy.* Springfield Illinois: Charles C Thomas 1965; Brecher R, Brecher E. *The Rays. A History of Radiology in the United States and Canada*. Baltimore: Williams & Wilkins 1969; Pallardy G, Pallardy M-J, Wackenheim A. *Histoire Illustré de la Radiologie*. Paris: Roger Dacosta 1989; Eisenberg RL. *Radiology: An Illustrated History.* St Louis: Mosby 1992; Rosenbusch G, Oudkerk M, Amman E, trans. Winter PF. *Radiology in Medical Diagnostics.*

Oxford: Blackwell 1994; Société Française de Radiologie et d'Imagerie Médicale. *Cent Ans d'Imagerie Médicale.* Paris: Samuel Merran [1995].

[xxiii] Burrows EH. *Op cit.*

[xxiv] The records of hospitals at Chard and Weston-Super-Mare have not come to light; those at Newton Abbot, Bideford and Yeovil are very incomplete and those of Stroud General Hospital are in manuscript and almost illegible.

[xxv] Those of Wincanton Memorial Hospital were burnt in 1948, and a similar fate is suspected of the Barnstaple Hospital records ca 1972. For this hospital, the only records of its past were found in the newspaper collection in the local studies library, and an incomplete collection of Annual Reports in the Devon County Record Office, Exeter.

[xxvi] Part of a nationwide survey begun in 1938, known as the 'Domesday Book of Hospitals'.

[xxvii] [England] For Chester Royal Infirmary; Liverpool Royal Infirmary; Liverpool Royal Southern Hospital; Northern Hospital, Liverpool; Leeds General Infirmary; The Newcastle Infirmary and its Medical School; Doncaster Royal Infirmary; Sheffield Royal Hospital; Hull Royal Infirmary; The Royal Infirmary, Sunderland; Southport General Infirmary; Manchester Royal Infirmary; Preston Royal Infirmary; The Royal Infirmary, Leicester; Newark Town & District Hospital; Nottingham General Hospital; Dudley Road Hospital, Birmingham; Tamworth Hospital; Worcester Royal Infirmary; The Radcliffe Infirmary, Oxford; Northampton General Hospital; Norfolk & Norwich Hospital; The Royal Berkshire Hospital; Windsor Hospital; the Kent & Canterbury Hospital; Royal Hampshire County Hospital, Winchester; Reigate & Redhill Hospital; Queen Victoria Hospital, East Grinstead; St Mary's Hospital, Eastbourne; the Royal Sea Bathing Hospital, Margate. [Wales] Cardiff Royal Infirmary; The Royal Gwent Hospital, Newport; Swansea General and Eye Hospital; The Caernarfon & Anglesey Infirmary. [Scotland] Dundee Royal Infirmary; The Royal Northern Infirmary, Inverness. [Ireland] The Adelaide, St. Vincent's, Richmond, Whitworth, Hardwicke, St Laurence, and Sir Patrick Dun's hospitals in Dublin; the Royal Victoria Hospital, Belfast.

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