Allvar Gullstrand: Prize and Prejudice

Allvar Gullstrand (1862-1930)

“Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning.” Albert Einstein.

A mathematician and an ophthalmologist, a physician and a physicist, the refuser and the recipient, the observer and the illuminist, Allvar Gullstrand’s contributions not only shaped the principles of optics but also the way ophthalmology is practised today.

Allvar Gullstrand was born on June 5, 1862 in Landskrona, a small town in Sweden. His school days were spent in Landskrona and Jönköping. There, a teacher piqued his interest in mathematics and taught him university level mathematics. For his higher studies, he entered the Uppsala University and also studied ophthalmoscopy, otoscopy and laryngoscopy in Vienna for a year. He completed his graduation from Stockholm in 1888. In 1891, he was appointed as a lecturer in ophthalmology at the Karolinska Institute. He became the first Professor of Ophthalmology at Uppsala University and established ophthalmology services and teaching program there. In 1914, he was granted Personal Professorship in Physical and Physiological Optics at the same University by the Swedish Government as an exceptional gesture to allow him to concentrate on his research work. He was honorary Doctor of Philosophy of the University of Uppsala, Jena and Dublin, one of the founding members and first President of the Swedish Ophthalmological Society, President of the Royal Society of Uppsala (1913-1914), President of the Swedish Academy of Sciences (1925-1926) and Professor Emeritus at Uppsala.[1,2] He was a recipient of the Graefe Medal of Deutsche Ophthalmologische Gesellschaft and was invested as Commander Grand Cross of the Order of Polar Star.[3]

Gullstrand’s work revolved around and revolutionized geometric and physiologic optics. He found Sturm’s description of passage of light rays through the lens system highly simplified. He developed mathematical equations and methods to examine the refracting media with higher order laws.[2] He treated the eye as a miniature camera. He built instruments to study the parameters of the eye: the curvature of the cornea and lens, distances between them and the refractive indices of the media. He put these in appropriate mathematical formulae and produced a sophisticated and accurate model of the eye, the Gullstrand’s schematic eye with six cardinal planes [Fig. 1][2,4]

The instruments designed by him included the photokeratoscope, an instrument to measure the corneal shape using reflexes made by concentric rings, and a slit beam illuminator. This is the slit-lamp that every ophthalmologist

heavily depends on today. It was based on the electric bulb with a tungsten filament invented by Nernst, focused upon a slit, thereby producing a rectangular beam that could be focused by an aplanatic lens. The slit was combined with a binocular microscope made by Czapski for Zeiss optics [Fig. 2].[5] He also invented the reflex-less ophthalmoscope by separating the systems of illumination and observation.[6]

Based on his measurements and observations of changes in the curvature of the cornea and lens during accommodation, he showed that while 2/3 of the accommodation depended on extracapsular mechanisms described by Helmholtz, 1/3 was contributed by intracapsular changes in the substance of lens.[5] Using fundamental principles of geometric physics, he formulated the first, second and third order imaging laws and use of aspheric surfaces in optical instruments.[8] Remarkably, his knowledge of physiological optics was to a large extent self-taught and he relied on the mathematics he had learnt in college and some principles he had developed himself.[2,3]

Some of his most notable works were, “Contribution to the theory of astigmatism”, which was also his doctoral thesis, 1890; “General theory of monochromatic aberrations and their immediate significance of ophthalmology”, 1900; “The true optical image”, 1906 and “The optical image in heterogeneous media and the dioptrics of the human crystalline lens”, 1908, which was awarded the Carius-Haller Gold Medal of Swedish Medical Association. Some of his other major works included “The objective differential diagnosis and photographic illustration of disabilities of the eye muscles”, 1892, “Photographic-ophtalmometric and clinical investigations of corneal refractions”, 1896, and “The pigments of central macula of the retina”, 1905.[5] His works were originally published only in Swedish and it was some time before he gained international acclaim. In 1922, Gullstrand demonstrated the diaphragm lamp in the American Society of Ophthalmology Congress in Washington and gained the title of ‘The Gentleman with the Lamp’. Most of his papers were filled with large amounts of facts, without lengthy proofs and were rather hard to decipher, leading his contemporaries to claim that “Gullstrand was so shrewd that nobody can understand him”.[2]

Allvar Gullstrand was awarded the Nobel Prize in Medicine and Physiology for his work on dioptrics of the eye. Till date, he remains the only ophthalmologist to receive a Nobel Prize for work in ophthalmology.[5] Other ophthalmologists to have been awarded the Nobel Prize include Fritz Pregl in 1923 for ‘invention of the method of microanalysis of organic substances’ and Walter Hess in 1949 for ‘discovery of the functional organisation of the interbrain as a coordinator of the activities of the internal organs’, but these were not for ophthalmology. Ragnar Granit, Haldan Keffer Hartline and George Wald were awarded the Nobel Prize in 1967 for ‘discoveries concerning the primary physiological and chemical visual processes in the eye’ and David H. Hubel and Torsten N. Wiesel in 1981 for ‘discoveries concerning information processing in the visual system’, but they were not ophthalmologists.[2]

Interestingly, Gullstrand is also the only individual to both receive and refuse a Nobel Prize. He declined the Nobel Prize in Physics in 1911, in favour of the Prize in Physiology or Medicine.[8] He was a member of the Nobel Physics Committee of the Swedish Academy of Sciences from 1911 to 1929 and its Chairman from 1922 to 1929.[1]

Tales of Gullstrand’s egotistic and chauvinistic attitude were fairly common. His Nobel speech, titled “How I found the mechanism of intracapsular accommodation” has been described as “tiresome and bombastic”. But what remains as the biggest controversy and conspiracy theory is his role in hindering the Nobel Prize being awarded to Albert Einstein. Einstein was nominated every year from 1910 to 1922, except 1911 and 1915, and by 1922 had had almost 60 nominations.[5] Gullstrand did not believe in Einstein’s Theory of Relativity and was strongly opposed to his Nobel Prize in Physics. He vehemently argued against his theory and turned it down as, “a matter of unproven belief and not of greatest utility to mankind”, a requirement in Alfred Nobel’s will. This was neither fair nor objective, and

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stemmed from the lack of acceptance of advanced mathematics and metaphysics. A series of well-preserved letters between Gullstrand and colleague and friend C. W. Oseen, also a member of the Nobel committee, bear evidence to Gullstrand's firm opposition and Oseen's rebuttals. Oseen was convinced of Einstein deserving the prize, especially with Niels Bohr's applications of his theories for his work on atomic structure, and managed to reach a compromise. Einstein ultimately received the honour in 1922, but for 'his discovery of the law of piezoelectric effect'. It was the same year that Bohr received the Nobel Prize in Physics. This is also the only time that a note has been published about what the prize was not awarded for, "theories of relativity did not count towards the prize". But Einstein did have the last laugh, because in his Nobel lecture, he addressed the Theory of Relativity and not the piezoelectric effect.

Every rose has its thorns, and despite his flaws, there is no denying the genius that Gullstrand was. "We remember Allvar Gullstrand for his genius and insight, but also for his forceful and unique character. Not many people like that are still around..." He was a giant among his contemporaries with enough qualities to fuel his ego. His work has formed the foundation and found practical implications even after more than a century. The Swedish Society of Medicine commemorated Gullstrand's 60th birthday in 1922 by initiating the Gullstrand Gold Medal awarded every 10 years. The list of recipients includes Alfred Vogt, Sir Stewart Duke-Elder, Hans Goldmann, Ernst Custodis, Ernst Barany, Sir Harold Ridley and Robert Machemer. The Gullstrand Medal bears the inscription 'Obscura Oculi Illustravit' meaning 'enlightening the darkness of the eye', an appropriate epitaph for one who invented the slit-lamp to look inside the eye.

Gullstrand retired in 1927 but continued his scientific work on optical system laws of fourth and fifth order. He died on 28 July, 1928 from a cerebral haemorrhage.

"An academic teacher and scientist who is not trembling with exhaustion at the end of a semester has not done his duty" - Gullstrand.

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