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George Ellery Hale's Internationalism

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Abstract. Throughout his career, George Ellery Hale thought globally. "Make no small plans" he was often heard to say (Seares 1939). His early sojourns to Europe, encountering the talent and resources in England and the Continent, contributed to his outlook. He knew that their patronage was critical to reach his personal goals. Here I outline the steps Hale took to establish the new "astrophysics" as a discipline, by creating the *Astrophysical Journal*, establishing a common language and then, through the first decades of the 20th Century, building an international collaboration to coordinate solar and later all astronomical research. The latter effort, which began in 1904, had expanded by 1910 to encompass stellar astronomy, when the Solar Union deliberated over spectroscopic classification systems, a standard wavelength system and stellar magnitude systems. This work continued through the fifth Union meeting in Bonn in 1913, which turned out to be the last because of the First World War. During the war, Hale became Chair of the National Research Council of the U.S. National Academy of Sciences, applying scientific talent to winning the war. He was also the Academy's Foreign Secretary, so Hale became deeply involved in re-establishing international scientific relations after the war. In conjunction with Arthur Schuster and Emile Picard, he helped found the International Research Council in 1919, which formed the framework within which the worlds of science reorganized themselves. From this, the International Astronomical Union was born. It was not an easy birth in a world still filled with tension and anger over the war; formative conferences in London and Brussels reflected the extremes. Nevertheless, its first General Assembly was held in Rome in 1922. It would be years before it became truly international, "in the complete sense of the word" (Elis Strömgren), but many of the proposals made during the years of the Solar Union concerning disciplinary standardization were ratified. I will concentrate on this latter story, remembering Hale for his devotion to true internationalism.

Keywords. George Ellery Hale, International Union for Cooperation in Solar Research, Astrophysical Journal, Astronomische Gesellschaft, American Astronomical Society, National Academy of Sciences

1. Hale's first travels abroad

Among Hale's many passions, I would list internationalism and interdisciplinarity at or very near the top. He always railed against rigidly constructed over-specialization, a characteristic of the traditional American astronomer, who focused solely on applying systematic techniques to the collection of data, while not asking larger questions that might inform that collection. But Hale was equally sensitive to building bridges between physical laboratories, observatories, and disciplines, stimulating hedgehogs and foxes to cooperate.† He frequently looked to European physicists as exemplars of the ideal scientist. In June 1914, after securing Ernest Rutherford as a speaker for a National Academy series honoring his father, William Ellery Hale, George Hale wrote "*Sir Ernest*"

† Apologies to Isaiah Berlin (Berlin 1953).

proclaiming, "*Much as I enjoy astrophysical research, it is after all only an applied science, and its results seem poor and meagre in comparison with the superbly fundamental conclusions which you derive.*"(Hale 1914).

Since his undergraduate years at MIT, Hale had been enamored with the great physicists and astronomers of Europe. As is well known from Helen Wright's still very adequate biography, as an undergraduate Hale was unusually direct approaching American leaders of science, like E.C. Pickering, C.A. Young and H.A. Rowland. As he built his first observatory in Chicago, the *Kenwood*, he courted their support and secured their endorsements, bringing many of them to its dedication in June 1891. They also wrote glowing letters of introduction for the 22-year old astronomer, which he used very effectively soon after the dedication when he and his wife Evelina set off for Europe to widen his circle of contacts and conferees. Starting in London, William Huggins was the first to grant an interview at Upper Tulse Hill. He also met with Lockyer, and toured James Dewar's laboratory. He visited Mary Agnes Clerke at Cardiff telling her of his desire to establish a truly international journal of astrophysics that would bring together physics and astronomy. Then he rushed off to Paris and Meudon, mainly to meet Henri Deslandres, who had just announced observations of prominence spectra. Overall, his primary goal was to meet European savants and raise interest in his plans for the journal.

2. The First International Astro-Physical Congress

Once back at the *Kenwood*, Hale redoubled his plans to build his next observatory, negotiating with William Rainey Harper of the new University of Chicago for a post to establish a new large observatory boasting the largest refractor in the world. But he was also exploiting his newly found European contacts to establish his international journal. A key opportunity came with planning for the *Columbian Exposition* in Chicago, set for 1893. Hale's father William was deeply involved, as was Harper; they all shared the hope that this world's fair would revive Chicago's reputation as a world-class city. Hale pushed to have an astronomical congress at the exposition, and that it be international. Many of those he met with in Europe agreed, especially those who shared Hale's vision of a "new astronomy." The International Congress, called the *World's Congress Auxiliary*, included sections on mathematics and on astronomy as well as "astro-physics." Indeed, the lure of holding international congresses in many areas of science reflected the rise of the disciplinary sciences and efforts to establish their legitimacy.

Typically, local interests generated these congresses, and Chicago was no exception, which entertained congresses in many disciplines, from physical chemistry to anthropology to philosophy. The Northwestern University astronomer G.W. Hough, director of its Dearborn Observatory, chaired the overall committee and devoted his efforts to the classical astronomy section, whereas Hale chaired the astro-physics section. As did the mathematics section, they all invited national and international names prominent in their respective disciplines. The Astronomy section included history, instrumentation, observational methods, physical astronomy, observatory architecture and design. Astro-physics, as it was then spelled, concentrated on spectrum analysis, photography and photometry. Advisors to the astronomical congresses included top astronomers from virtually all the major observatories in Europe, the British Isles, North and South America. The Congress took place in August 1893 where everyone marveled at the huge equatorial mounting, including the pier and tube, of the newly announced Yerkes Observatory 40-inch refractor that dominated the floor of the "Manufacturer's Building." Twenty-five-year-old George Ellery Hale had made his mark. But this was only the first step.

3. Founding the ApJ

In the wake of the Congress, and after several months studying in Berlin, Hale set to establishing his international journal of astrophysics. He had already invaded the sanctum

of the leading American journal, W.W. Payne's *Sidereal Messenger*, morphing it into the short-lived *Astronomy and Astrophysics* in 1892. Within two years it morphed again into, as Hale initially called it, *The Astro-Physical Review – an International Journal* which upon first publication in January 1895 became *The Astrophysical Journal: An International Review of Spectroscopy and Astronomical Physics.* It boasted an international editorial board of astronomers and physicists including Cornu, Dunér, Huggins, Tacchini, and Vogel, complementing the Americans Langley, Michelson, Pickering, Rowland, and Young. The first paper in volume 1 was by A.A. Michelson, reaching out to astronomers to help them better understand the physical constraints involved in spectroscopic equipment and how their design can influence what is detected and measured. Accordingly, as Hale enumerated in the same issue, his rationale for the new journal was a place where "*the astronomer and physicist should be able to meet on common ground, and this only an astrophysical journal can supply*" (Hale 1895). Here he also explained his rationale for its international character. In tune with the tendency to recognize national memberships among congresses of that day, his board of editors represented different countries and were chosen on that basis from Germany, Great Britain, France, Italy and Sweden, "*for it was felt from the first that unless the journal were made truly international in character it could not be a success.*"

Among the immediate goals of Hale's new ApJ was the standardization of the wavelength scale and wavelength determination, both leading to spectroscopic chemical identification and the production of systematic radial velocities. There had been much debate in the previous decade over these matters and considerable rancor in some corners, mainly over the identification of the chemical identity of the chief nebular line. Accordingly, Hale and his associate editor James Keeler convinced Henry Rowland to use the ApJ as one of his chief means of establishing standard wavelengths in the solar spectrum. In its first years the ApJ editorial board also deliberated over standards for publishing spectroscopic as well as photometric data.

Throughout the rest of the 1890s, Hale used the ApJ as a forum to promote better communication between physicists and astronomers worldwide. He also used the 1897 dedication of his new Yerkes Observatory in Williams Bay as a platform to establish a new society, the *Astronomical and Astrophysical Society of America*, which became the AAS in 1914.

Soon after he was elected to the *American National Academy of Sciences* in 1902, engaging the support of senior physicists and astronomers in the academy, including W.W. Campbell, S.P. Langley, A.A. Michelson and C.A. Young, he formed a Committee on Solar Research under the NAS imprimatur. Langley, of course was a key political player. Secretary of the *Smithsonian Institution* and Director of its Astrophysical Observatory, Langley's support was critical. During this time, Hale had been in contact with Langley's assistant, Charles Greeley Abbot, who was anxious to establish solar monitoring stations around the world that would follow the amount and character of the Sun's heat. Abbot cautiously advised Hale how to win Langley over to his view of cooperative work.† With Langley secured, Hale had a three-pronged platform to pursue what was then his largest concern, very much in tune with Abbot's dream.

4. "Co-Operation in Solar Research"

Hale, constantly on the move, soon abandoned Yerkes and Chicago to build what became the *Mount Wilson Solar Observatory* in southern California, which was where Abbot wanted to initiate his solar monitoring at different elevations up the mile-high road leading to Wilson's Peak. In January 1904, newly arrived and active on many fronts in Pasadena, California, Hale wrote to A. Riccò of Catania, among other solar observers, asking for advice on setting up a new form of world-wide organization that would make it

† Abbot to Hale, 20 January 1903; 17 January 1904. Hale Papers microfilm edition, reel 1.

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possible to keep continuous track of solar activity. He made the point that the National Academy Committee he chaired had been a systematic step to build a coalition that would be debated and, hopefully, formed, at a new set of scientific congresses to be held in St. Louis, Missouri, in conjunction with the World's Fair there starting in April and lasting the rest of the year. The Fair included the first Olympic Games held in the United States, and was the site for many spectaculars in science and technology.

His appeal to Riccò was all-encompassing. He hoped to build upon present organizations such as the *Solar Physics Committee* of the Royal Society, as well as its past *Joint Solar Eclipse* committees, and similar committees of other countries that supported solar research. He deplored the fact that of some 44 refractors spread around the world larger than 14 inches, only two of them were systematically devoted to solar research. If more of them could be equipped with standardized spectroheliographs, and operated according to "*some general plan of research,*" their value would be "*greatly increased*" (Riccò 1904). Most importantly, Hale saw solar studies informing not only astronomy, but also laboratory-based high-temperature physics and even problems in mathematical physics where the data would stimulate theoretical explorations of the solar constitution and structure.

In the next few months, Hale wrote to other European astronomers. His strategy was to employ his *Academy Solar Committee* as the means to invite not individuals, but their respective scientific bodies to join in. Thus in May and July 1904, he informed both J.C. Kapteyn and W.H. Julius that the *American National Academy* had formally invited their Academy of Sciences in Amsterdam to form a similar committee "*to consider a general plan of co-operation in solar research.*" Both Julius and Kapteyn were in full support, the latter soon reporting that the Dutch Academy had approved the committee (Hale 1904).

Hale's strategic appeal brought many leading physicists and astronomers from Germany, Holland, France and England to the 1904 Congress. There, Hale, Arthur Schuster, H.H. Turner and Ludwig Boltzmann called upon the body to "*adopt a definite plan of organization, and to discuss in a preliminary way the details of a program of observations and other matters, such as standards of wavelengths, which will require subsequent consideration by the various committees before adoption.*"† Hale was keenly aware that American astronomers, in particular, emphasized routine work above all else, and so he hoped to address this imbalance by gaining the support of his European colleagues. Hale was careful, though, to assure everyone that their contributions would be credited properly. On the one hand, he observed, cooperative work has led to the careful design of large investigations where the designers "*assume that the participants in a co-operative undertaking are to perform their respective parts like so many machines, following a hard-and-fast programme from which no deviation can be permitted.*" But, Hale went on to state, this sort of plan was opposed by many, "*who think that the future of science depends in far greater degree upon the development of new ideas and the encouragement of individual genius than upon the accomplishment of any piece of work, no matter how extensive it may be.*" Hale made sure that both types felt needed.‡

Cooperative work in science at the international level was far from a new idea in 1900. They ranged from the late 18th century efforts of Alexander von Humboldt to team up with Biot, Gay-Lussac and others to create international geomagnetic campaigns called *World Magnetic Surveys.* The *Magnetic Crusades* continued these efforts at mid-century, led by the British. Cooperative programs in astronomy were at first geodetic in nature, determining the figure of the Earth from ever-larger cooperative 'arc of the meridian' surveys. Possibly the first truly international cooperative effort was the observation of

† *Transactions of the International Solar Union*, 1906, vol 1, pp. 3–4.
‡ Hale, ISU Trans vol 1, pp. 14–15.

the transits of Venus in 1761 and 1769 to determine the solar parallax. This sort of cooperation required simultaneous observations from widely spaced points. Also in this category were observations of asteroids and celestial mapping by photography, organized by astronomers as widely based as Amédée Mouchez and David Gill in the 1880s, culminating in the worldwide *Carte du Ciel* and the *Eros Campaign* of 1900–1901. A somewhat different form of cooperation appeared as the *International Latitude Service* in 1898 centered in Turin, with standardized observatories across the globe.

Hale's vision, however, was more in line with the philosophy of the *Astronomische Gesellschaft*, which had formed in the 1880s. The AG was dominated by positional astronomers and orbit calculators and was very successful in establishing lines of communication and standards of practice. Hale wanted to organize a new disciplinary entity along similar lines, centered on the physics of the stars, namely astrophysics. The central object of his interest therefore was the Sun, and he sought out ways to create a forum out of which standardized modes of investigation, description and interpretation could be established. Most of the papers presented at the Congress in St. Louis dealt with developing a new system of wavelength standards. This was clearly the heart of the meeting, and the interest of those attending, as papers representing the perspectives of the United States, France and Germany were read in turn, and debated. At the end of the meeting, Hale received the endorsement he had hoped for from astronomers like Arthur Schuster and H.H. Turner, the creation of the *International Union for Cooperation in Solar Research.*

5. Making Cooperation International

Standardization was central to the creation of professional identity within and across disciplines and was then a common focus in chemistry, physics and electrical engineering. Thus in creating the ISU, Hale had established a forum for debating the pros and cons of the standards by which astrophysicists, solar physicists, and spectroscopists would eventually communicate their observations and deductions. The history of subsequent meetings of the ISU, in fact, are expansions on this theme.

At its second meeting, at Oxford in September 1905, the first official meeting of the ISU, wavelength standards were again the main topic. The Union decided that a new system was required, using the absolute position of a single line, which they called an ångström unit. The chief protagonists formed a committee to work out the details: to decide on which spectral line and which secondary and tertiary standards to adopt. They also defined standard laboratory conditions for the production of these standards. They and others then went on to develop standards of practice in the design and use of the spectroheliograph, and in the measurement of solar radiation, going so far as to adopt a single instrument design to allow for the comparison of observations over widely separated areas.

The third meeting was held at Meudon in May 1907, with 36 representatives from France, 4 from Germany, 13 from England, two from the USA (Hale and Joseph Ames), and one or two each from seven other countries; it was strongly European. Again, resolutions on standards of practice dominated, although now, more room was given over to individual papers, more discussed than formally read. Reports were made, however, by the half-dozen standing committees of the union now charged with the actual planning for standards: these included radiation intensities, wavelength standards, standards for the design and use of the spectroheliograph, as well as committees for standardizing the determination of solar rotation, the organization of eclipse expeditions, and the investigation of sunspots.

By the time of the fourth meeting of the Union, however, set for September 1910 at Hale's own Mount Wilson solar observatory, the stage was set to expand beyond

the Sun (DeVorkin 1981). Present at the first meeting in St. Louis was J.C. Kapteyn, representing W.H. Julius of the Amsterdam Academy of Sciences. Few people were to have as much influence over Hale as did Kapteyn, who was then formulating his *Plan of Selected Areas*, which required not only the participation of many observatories, but international agreement on nomenclature, magnitude systems, classification of stars by their spectra, and methods of reduction for brightness, colors, positions and motions. Cooperative programs in stellar astronomy and astrophysics were then certainly in the air. W.W. Campbell at Lick called for a worldwide campaign to collect information on spectroscopic binary stars, which required standardized nomenclature again. In addition, through Hale, Kapteyn had already formed an ad hoc committee on the *Plan of Selected Areas* under the auspices of the ISU.

Kapteyn, along with people like Edwin Frost, had been concerned about cooperation at a time when they feared that duplication of effort was making astronomy very inefficient. Frost, in particular, had been left holding the bag at Yerkes when Hale moved to California, and felt responsible not only to maintain the observatory but also *the Astrophysical Journal* at a time when astrophysical data flowed in from many disparate, uncoordinated sources. In 1904, Frost reported that since the 1860s, there were some 23 distinct systems for the spectral classification of stars, and many were still in active use. This fact further compounded Frost's woes as the ApJ editor. Somehow, the growing community of astrophysicists had to be convinced to cooperate. With Kapteyn, Frost and Schuster carefully orchestrated to lobby for the expansion. Hale had no qualms about modifying the mandate of the ISU.

Hale carefully orchestrated the expansion. In June 1907, writing from London where he had been conferring with David Gill, Hale advised Kapteyn on how they should proceed. He admitted to Kapteyn that he had formed the Solar Union in a way that did not centralize power in any one person or observatory, letting the Union itself be the authority. "*I have no doubt that you will share my view that full credit should be given to those who may be associated with you, for the purpose of encouraging them to further effort.*" Hale then added: "*While I think there are great advantages in selecting the best men for the difficult phases of the work, as you have done [in the Plan of Selected Areas], it seems possible that a more permanent though perhaps less effective organization might be secured through an international conference* (Hale 1907). This was the platform Hale carefully constructed to reassure each participating country that they would share in the profits. Nevertheless, there were always personalities involved.

As was well known, E.C. Pickering of Harvard was the man to win over in order to expand the scope of the Union. Pickering was the chair of the Committee on Stellar Photographic magnitudes of the *Astrographic Chart Conference* of the continuing *Carte du Ciel* effort, and Hale worked hard to make the Harvard director also see the ISU as the best way to gain control over any decision to standardize systems of spectral classification. The September 1910 meeting was to be on American soil, thousands of miles away from the home turf of any of Pickering's competitors. It would be the most sympathetic forum Pickering could hope for, especially since Hale saw to it that Pickering chaired the meetings in September that called the question of standardization.

Hale and Pickering also created the means for maximum deliberation by orchestrating a meeting of the *American Astronomical Society* at Harvard on the East Coast. The strategy was to attract the European visitors first to Boston, and then hire a special train to carry them all to California. It is not surprising, therefore, that a little diary Pickering kept during his western journey, on a train filled with astronomers, recorded meetings "*wherever I sat down.*" At one point, as the western bound *Santa Fe* train was nearing Flagstaff, and just after Karl Schwarzschild agreed to abandon his Potsdam system of magnitudes in favor of Pickering's Harvard system, Pickering also penned in

his notebook: "*My part in this will be regarded as one of the most important things I have ever done.*"†

At the meeting, Schuster eloquently urged the ISU to expand its scope to include stellar astrophysics. Both he and Turner argued that solar physics and stellar astrophysics had to become one discipline, and the 60-odd astronomers who heard them agreed. They would stick to astrophysics, however, which in that day meant all applications of spectroscopic technique. In this way, Turner commented, no conflict would exist between the ISU and the venerable and powerful *Astronomische Gesellschaft*, or with the *Astrographic Chart Conference*. Accordingly, a new committee on stellar spectral classification was established at the Mount Wilson ISU, leaving Pickering's magnitude committee for the *Astrographic Chart Conference* intact. And Pickering soon was voted chair of the spectral classification committee of the Union as well. So he won on both counts. Schuster, quite rightly, worried over potential conflict with the *Astronomische Gesellschaft* in the years ahead, and having Pickering on both committees was certainly an asset.

The Harvard systems were declared provisional at the next meeting of the ISU in 1913 in Bonn, which was also the last meeting of the ISU. In its wake, overwhelmed by the growing war, the ISU's titular parent body, the largely ceremonial *International Association of Academies*, was torn apart by political partisanship in the Central Powers and among the Allies. The ISU's plans to meet in Rome in 1916, and Cambridge in 1919, were never realized.

Historian Daniel Kevles has poignantly described how Hale was drawn into creating a new form of advisory body, called the *U.S. National Research Council*, to aid winning of the war after the *Lusitania* was sunk in 1915, followed by the *Sussex* in March 1916. Hale campaigned to create the NRC as an activist element of the National Academy to enlist the scientists of the nation to engage in a wide range of projects for both offensive and defensive weapons. Thus, science was mobilized and soon demonstrated its value. All the while, as Hale hoped, science became better appreciated by the state and industry as a factor in national strength. Above all, the NRC showed how cooperation between disparate bodies in academe, the military and government was as important as interdisciplinarity, and more to Hale's goals, demonstrated the value of advancing research in America (Kevles 1968).

After the Armistice, representatives of the scientific academies of the victorious countries met first in London and then in Brussels to create a new international organizational scheme, again framed by Hale, which he called the *International Research Council*. In spirit, it mirrored the structure of his American progenitor, but all Central Powers organizations were excluded because of bitterness over the war, including the defunct *International Association of Academies* and even the venerable *Astronomische Gesellschaft*. Delegates now proposed that all existing societies disband and reorganize themselves by discipline into a "*single society formulated to serve the purposes of all the associations from which they should withdraw.*" Membership, however, was initially limited to the Allies, but soon opened to the neutrals (Campbell and Stebbins 1920, p. 349).

A group of astronomers met in Paris to plan for a meeting in Brussels in July 1919 to create the IAU. Their charge was to make the IAU represent all forms of astronomy practised by the old ISU and the *Astrographic Chart Conference*. Accordingly, in July 1919, 33 astronomers representing allied and neutral countries met in Brussels to chart their course, which resulted in the first meeting of the General Assembly in Rome in 1922, sanctioned by some 19 participating countries and their governments. Many of the ISU's committees were reformed, and new ones added to complete the suite. The framework of the old ISU even survived intact. It took a devastating world war, but Hale's vision for international astronomy was finally a reality.

† Ibid.

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6. Resources

Portions of this essay were adapted from DeVorkin, *The International Union for Cooperation in Solar Research: Prelude to the IAU*, pp. 117–118 in: *Highlights of Astronomy* 10, (1995), as well as DeVorkin (1981). Primary resources included the Hale Papers, Microfilm Edition (Caltech) as well as Daniel J. Kevles, The Physicists: The History of a Scientific Community in Modern America, Revised Edition (Harvard University Press); Helen Wright Greuter, Explorer of the Universe: A Biography of George Ellery Hale. Harvard, 1966, revised. Helen Wright, Joan N. Warnow and Charles Weiner. The Legacy of George Ellery Hale. (MIT 1972).

7. Discussion

MONTMERLE: In some group photographs you showed, there are a few women. Who were they? Just accompanying persons, or involved in the groups for professional reasons? The status of "Women in Astronomy" is important for the IAU – even in the past ...

DEVORKIN: There are two women in the detail of the group photograph I showed. Mrs. Catharina Elizabeth Kapteyn ("Elise"), the wife of J. C. Kapteyn, is in the first row, and Mrs. W. P. Fleming is to her left. Though not a professional astronomer, Elise was nevertheless very much a part of her husband's professional life. Fleming was one of Pickering's lead computers and attended for professional reasons. Other women attended as participants and wives. In addition to Fleming, who was the only one from another observatory, four were computers at Mount Wilson, including Phoebe Waterman, Cora Burwell, Ruth E. Smith and Clementina Griffin. Burwell authored and co-authored some 45 papers and essays with other Mount Wilson astronomers through 1953. Waterman was one of the first two women to gain a PhD in astronomy from Berkeley in 1913, and from there spent a short time at Cordova working for Perrine. When she soon married Otto Haas, at least one astronomer interpreted it as a loss to astronomy; a "change of occupation" (William Wallace Campbell writing to Edwin Frost, March 2, 1914, Courtesy of Thomas Williams, Donald E. Osterbrock and the Mary Lea Shane Archives of Lick Observatory). Waterman Haas continued to be devoted to astronomy, volunteering for the AAVSO, and becoming a patron. The *Phoebe Waterman Haas Public Observatory* at the *National Air and Space Museum* is named to honor her memory.

Acknowledgements

The Hale Observatories, courtesy AIP Emilio Segrè Visual Archives.

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