As International as They Would Let Us Be

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Received July 15, 2015; accepted August 28, 2015

Abstract Astronomy has always crossed borders, continents, and oceans. AAVSO itself has roughly half its membership residing outside the USA. In this excessively long paper, I look briefly at ancient and medieval beginnings and more extensively at the 18th and 19th centuries, plunge into the tragedies associated with World War I, and then try to say something relatively cheerful about subsequent events. Most of the people mentioned here you will have heard of before (Eratosthenes, Copernicus, Kepler, Olbers, Lockyer, Eddington…), others, just as important, perhaps not (von Zach, Gould, Argelander, Freundlich…). Division into heroes and villains is neither necessary nor possible, though some of the stories are tragic. In the end, all one can really say about astronomers' efforts to keep open channels of communication that others wanted to choke off is, "the best we can do is the best we can do."

1. Introduction

Astronomy has always been among the most international of sciences. Some of the reasons are obvious. You cannot observe the whole sky continuously from any one place. Attempts to measure geocentric parallax and to observe solar eclipses have required going to the ends (or anyhow the middles) of the earth. Even now, when satellites at L2 can watch nearly the whole sky nearly continuously and heliocentric parallax has replaced geocentric as the more interesting, we are still sufficiently thin on the ground that somebody must cross mountains, oceans, and borders to assemble a critical mass of folks who are wise enough to be interested in the topics you are interested in. How thin? The total number of astronomers in the world has not been counted, but two or three times the membership of the International Astronomical Union or the American Astronomical Society (one-third of everything expensive happens in the U.S., it used to be one-half) suggests 25–30 thousand. A quick look around confirms that physicists and chemists, not to mention microbiologists, greatly outnumber us. On the other hand, we have, uniquely, the IAU, which, unlike the other 30 international scientific unions that are part of ICSU (International Council for Science, formerly International Council of Scientific Unions), has individual, and not just national or societal, members. This means that a typical IAU Symposium attracts two or three hundred participants (not all members) from two or three dozen countries. So, how did we get here; what have some of the obstacles been; and what sorts of international collaborations are with us for the present and future?

2. Before and after the Treaty of Westphalia

Was Eratosthenes the first astronomer with an international collaborator? (Carman and Evans 2015) Not really, for his 2nd century BCE measurement of the circumference of the earth was carried out when Alexandria and Syene (now Aswan) were both part of a sizeable Ptolemaic Egypt. Cyrene, where he was born, is in Libya today, and yes, those we think of as "the Greeks" worked in lands now part of Turkey, Egypt, Italy, and other places, as well as Greece. Similarly, one gets the impression from comprehensive histories of astronomy (North 2008; Hoskin 1997) that the golden age of Arabic/Moslem astronomy (though some of the practitioners were actually Christian and Jewish) coincided with the largest extents of regions governed by caliphates and other Moslem empire-like structures. In addition, Arabic astronomy also drew on earlier Greek, Persian, and Indian writings.

In contrast, the Europe of the 16th century, across which Copernicus and his first adherent, Rheticus, wandered, had nothing quite like modern boundaries to be crossed, though it was certainly possible for astronomer-astrologers to get into trouble away from home, or even close to where they had been

Figure 1. Central Europe during the life of Rheticus. The rivers, seas, and cities haven't moved very much, but the national and other political boundaries are a different story. (From Danielson 2006, with permission of the author).

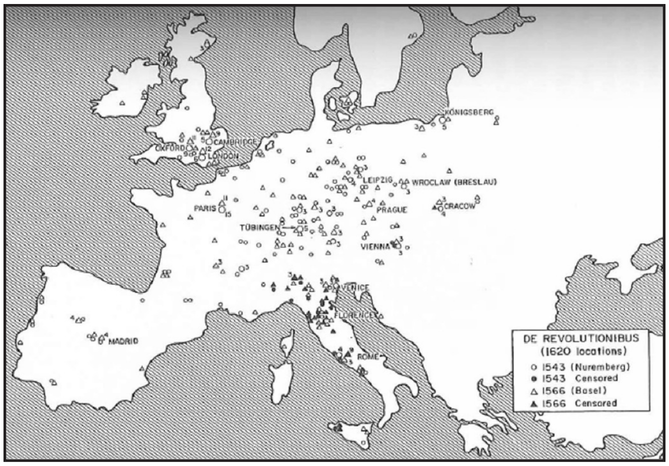

Figure 2. Locations of the censored (filled symbols) and uncensored (open symbols) copies of *De Revolutionibus* in 1620. Circles are the first edition (Nuremberg 1543) and triangles the second edition (Basel 1566). Also during the 15th and early 16th centuries, Jesuits traveled to India, China, and Japan. Their purposes were primarily apostolic rather than astronomical, but they brought with them some astronomical instruments and tables that permitted more accurate calculations of planetary motions than those then in use in the east. These were typically based on Tycho's rather than Copernicus's picture of the solar system. North (2008, p.151) says that "the long-term effect of the work of the Jesuits was great, even though between 1600 and 1640 every missionary in Japan was put to death or deported, while a similar fate met missionaries in China in 1665." (From Gingerich 2004, with permission of the author).

born (Danielson 2006; Ferguson 2002). On a map of the period (Figure 1) we recognize most of the city names but have to draw in modern national boundaries for ourselves. Copies of *De Revolutionibus* had diffused over much of the same territory by 1620 (Figure 2). Nearly all of the censored copies were in Italy, though France, Spain, Vienna, and Poland were also Catholic. They seem to have regarded the censorship as part of an internal Italian dispute (Gingerich 2015). Pan-European book fairs were also part of this pattern (Gingerich 2004). Kepler had just participated in one in Leipzig when he rode on to Regensburg and died in 1630.

It is relevant to subsequent astronomical history that the potential importance of astronomical observations and tables for navigation became clear at a time when England and France were largely unified countries, while what we now think of as Germany and Italy were patchworks of territories answerable to princes and prelates, dukes and doges, not to mention electors (of the Holy Roman Emperors). Thus the first two each had a single major observatory at Greenwich and Paris (and also single scientific societies and journals established in the 1660s) while the latter two gave birth to multiple observatories in multiple states, universities, and all.

The Treaty and Peace of Westphalia in 1648 ended the Thirty Years' War and is said to have established modern nation-states. England, Poland, Moscow, and Turkey were the only European powers not represented, while representatives from Spain, the Low Countries, the Holy Roman Empire, France, Sweden, other German entities, and the Pope were there. Sweden (which was much bigger then), France, Brandenberg, and Bavaria were confirmed in their sovereignty over their territories. The Netherlands and Switzerland were recognized as independent republics, and the member states of the Holy Roman Empire were given full territorial sovereignty over their own territories, greatly weakening the Empire (neither Holy, nor Roman, nor an Empire, as you don't need me to tell you).

The Thirty Years' War had killed a quarter to a third of the population of the German states that came to Westphalia. The underlying disputes about national territory and about heliocentric cosmologies affect what we call things to this day. Riccioli, who named most of the lunar features in 1651, gave more visible, bigger craters to the good guys and the little ones to the bad guys, so Ptolemy and Tycho are large and in regions where shadows away from full moon make them easily visible, while Copernicus and Kepler are "tossed on the Sea of Storms" (Livingston 2015). Kepler himself led a sufficiently storm-tossed life, and, in due course, his grave was destroyed by the Swedes in the sack of Regensburg (Livingston 2015) or perhaps just lost (Ferguson 2002).

While Kepler is with us, let's not suppose that relations among him and his contemporaries elsewhere were always sunny. Galileo sent telescopes to distinguished men throughout Europe, but refused Kepler's request for one (Bucciantini *et al.* 2015). Claude Mellan's 1634 map of the moon, for instance, came from a telescope with parts provided by Galileo.

Kepler had predicted the 1631 transits of Mercury and Venus, but did not live to see them, either with or without a telescope. The Mercurial was seen from Paris by Gassendi; Venus in 1631 took place during European night; but 1639 was recalculated and observed in England by Jeremiah Horrocks and William Crabtree (J. P. Luminet in Hockey *et al.* 2014 [BEAII hereafter], p. 478). William Gascoigne, another of their collaborators, was killed fighting on the royalist side in the English Civil Wars (1644), though Kepler had dedicated his *Harmonice Mundi* to James I.

Tycho and his contemporaries were able to show that the great comet of 1577 was outside the orbit of the moon using observations made just within Europe (Leverington 2013). But to measure an accurate distance for the earth-sun separation (the Astronomical Unit) using transits of Venus required a longer baseline. Edmund Halley put forward the idea in 1716 in the same time period when he organized simultaneous observations of a lunar eclipse between St. Andres and Paris to get an accurate measure of their difference in longitude. James Gregory had suggested using transits of Venus around 1670 (T. A. Dobbins in BEAII, p. 850–851). Halley himself had seen a transit of Mercury from St. Helena in 1670, when he was mapping the southern sky (Hirschfield 2001; K. K. Yeomans in BEAII, p. 891–894).

Another generic reminder: the colonial empires of Spain, Portugal, England, and France were gradually spreading outwards, and Halley at St. Helena was not on foreign soil. It was a coaling station for the East India Company by then. Napoleon at St. Helena is a different story (as well as a very elaborate solitaire game, requiring two decks of cards).

On the other hand, Nicolas-Louis de La Caille from the Paris Observatory, working at the then-Dutch Cape of Good Hope from 1750 to 1754, was an international astronomer (cataloguing southern stars and recording 42 nebulae and star clusters), the more so as he coordinated simultaneous observations by

Joseph Lalande from Berlin of positions of the moon, Venus, and Mars, aiming to measure geocentric parallaxes (M. Murarain in BEAII, p. 536–537). Lalande was, of course, French, but was “well received by Frederik II” in Berlin (S. Dumont in BEAII, p. 1264–1265). He was also part of an observing campaign for the 1753 transit of Mercury, but from nearer home in Meudon. That campaign was organized by Joseph-Nicolas Delisle, who was back home from spending 1725–1747 in Russia, where he established the St. Petersburg observatory for Peter the Great.

This brings us to the Venus transits of 1761 and 1769, which seem to have involved every living astronomer of the period of whom you have heard, and some you have not, from eight different countries, going to many more sites expected to be under friendly control. Astronomer Royal Nevil Maskelyne went to St. Helena, Charles Green to Tahiti, and Charles Mason and Jeremiah Dixon were in South Africa for both events, taking time in between to survey the line that bears their name (between Pennsylvania and Maryland). Saddest is the case of Guillaume Le Gentil, who headed for the French colony at Pondicherry to find it had just fallen to the British. Rather than make two trips, he stayed there for 1769, only to be clouded out. Returning to France, he found his job and possessions in other hands and himself officially dead (Hirshfield 2001, p. 64).

While transits were important for measuring the earth-sun distance and timing of eclipses for pinning down the theory of the moon’s motion, measuring the lengths of arcs of the meridian in far away places was needed to settle whether the earth was an oblate or prolate spheroid, which sent Louis Godin from France to Peru in 1736 and de Maupertuis to Lapland. It is oblate, like Newton said.

3. The long nineteenth century

We know when it ended—August 1914. But when did it begin? Historians have suggested 1789 (U.S. Constitution and French Revolution). The routing of Napoleon would seem an alternative. For our purposes, however, any date between 1769 (the end of Le Gentil’s miserable experiences with the transit of Venus) and 1798–1799 will do. The latter saw what was arguably the first international conference, the International Commission on the Metric System in Paris (Mechain and Delambres are names to look up in BEAII). Push back a decade if you wish to take in the vertical circle made by Ramsden (England) for Piazzi (Italy) with which the latter found the first asteroid in 1800. Fraunhofer in Munich made the large reflector for Dorpat, and William Herschel’s reflectors were also sold all over the place, in years around 1800. North (2008, chapters 14 and 15) has a good deal more on who built what for whom, which were the biggest 19th century telescopes, and so forth. For instance, the Clark (U.S.) 30-inch mounted by Repsold (Germany) for Pulkova (Russia) was briefly the world’s largest refractor.

Technological advances came not just to telescopes, but, vitally for eclipse expeditions, transits of Venus, and other long-range collaborations, to transport by land (the railways) and sea (steamships). Never again would there be anything quite like Le Gentil’s Pondicherry adventure or Captain W. S. Jacob’s 1862, 100-day voyage back to Madras, which ended with his death soon after, surely at least in part as a result of the very limited diet enroute. His daughters’ diary of the voyage can be accessed from a Jacob family genealogy site.

Table 1. Nationalities of astronomers who met at Lilienthal in 1800.

Name	*Nationality or Location*
Bode, Johann Elert	German
Brugge, Thomas	Danish
Burckhardt, Johann Karl to Jean Charles	German to French in 1799
Bürg, Joseph T. or Johann Tobias	Austrian
Gildemeister, Johann	German
Harding, Karl Ludwig	German
Herschel, Wilhelm or William	German to English
Huth, Prof.	Frankfurt am Oder, German
Klügel, Georg Simon	German
Koch, Dr.	Danzig, German
Maskelyne, Nevil	English
Mechain, Pierre	French
Melanderhielm, Prof.	Stockholm, Swedish
Messier, Charles	French
Olbers, Wilhelm	German
Oriani, Barnaba	Italian
Piazzi, Joseph (Guiseppe)	Swiss to Italian
Rollegienrath, Schubert	Petersburg, Russian (?)
Schröter, Johann Heironymus	German
Sniadecki, Jan	Krakow, Polish-Lithuanian
Svanberg, Prof.	Uppsala, Swedish
Thulis, Jacques	Marseilles
von Ende, Ferdinand (Adolf)	German
von Zach, Franz	Hungarian
Wurm, Johann Friedrich	Stuttgart, German

The first international scientific meeting was conceivably the International Commission on the Metric System in Paris in 1798–1799, one of whose participants, Brugge, appears in Table 1. Our hero, however, is Janos Ferenc (Franz) von Zach, whose career swept across Europe (Hungary, Vienna, Lemberg, Paris, London, Seeberg Observatory near Gotha, by increments to Geneva, Naples, and back to Paris, L. Szabados in BEAII, p. 2369). In 1798 he brought together an international group at Seeberg to think about the planet that, according to Bode’s Law (not a law and not due to Bode, of course), should orbit between Mars and Jupiter.

The organization was fully established in 1800 at Lilienthal, under the presidency of its director, Johann Schröter. Table 1 lists the members, a list generously provided by Gudrun Wolfschmidt (2015). At least 12 of the 25 were pretty much German, and most of the others would have had German as a strong second language. Piazzi actually found the first asteroid (Ceres) on 1 January 1800, shortly before the coordinated observations were to begin. I have always wondered whether it was in the zone he was supposed to “police,” the group having been variously called the Vereinigen Astronomischen Gesellschaft, Astronomischen Gesellschaft Heimatverein, celestial police, and Himmelspolizei.

The principal was sound; Olbers doing his detective job found (2) Pallas in 1802, followed by (3) Juno in 1804, and (4) Vesta in 1807, found by Schröter’s assistant Harding (Wolfschmidt 2001; Gerdes 1990). But in April 1813, the Lilienthal Observatory was heavily damaged by French soldiers retreating from Moscow, its records and equipment taken or destroyed (C. J. Cunninghan in BEAII, p. 1953). The next asteroid was not found until 1845 by Karl Hencke. It was (5) Astra, and he had been working for 15 years from his own observatory at Driesen to find it. He also served in the Prussian military against Napoleon in 1813–1815. The last asteroid I've heard about being named for a colleague (Robert B. Brownlee) has a five-digit number, 15970.

Progressing through the century we find some well-known star catalogues (BD, CD, AGK) with input from observatories in more than one country, leading up to the *Carte du Ciel*. Those D's mean Durchmusterung, and it was Argelander of Bonn who proposed to the new Astronomische Gesellschaft that 17 observatories (many German) should produce a catalogue of all the stars down to 9th magnitude with accurate positions (Hoskin 1997, p. 259). The lagging project was overtaken by the application of photography to positional astronomy, and Admiral Mouchez, director at Paris, prompted by suggestions from Prosper and Paul Henry, convened 56 scientists from 19 nations to produce both a photographic atlas of the sky (the *Carte du Ciel*) and a catalogue with positions of all the stars down to 11th magnitude in 1887 (Hoskin 1997, p. 259; North 2008, p. 519).

All the observatories were supposed to use identical astrograph telescopes and agreed-upon methods of photography and imaging. The Permanent International Committee of the *Carte du Ciel* was an important entity from then until World War I, though no American observatory was involved. The exclusion of Germany from post-war scientific organizations (next section) required much rearrangement of the zones, and the initial IAU Commission *Carte du Ciel* (23) had H. H. Turner of England for its president. The last parts of the catalogue were published in 1964 (North 2008; Hoskin 1997; Blaauw 1994). Commission 23 was still *Carte du Ciel* in 1970, but then merged itself into Commission 24 (stellar parallax and proper motion), though some of the astrographs were still in use, and some of the plates began to be applied to proper motion studies (Dieckvoss 1970). Hale's International Union for Solar Research founded in 1907 was the other major astronomical organization in 1914. At the 1910 meeting in Pasadena, Karl Schwarzschild suggested that its remit should expand to take in all of astrophysics, and there seemed to be no objection. But at the time of the last, 1913, meeting in Bonn, it was still just the Solar Union.

As transport became faster and more reliable through the century, solar eclipse expeditions and the 1874 and 1882 transits of Venus established the custom of astronomers from many places going to many other places, most often North American and the colonies of European powers, but the long lists of eclipses attended by Lockyer (founder of *Nature*), Copeland (Astronomer Royal for Scotland), Maunder (of the minimum), Dyson (Astronomer Royal for England), and many others also took in Japan, Peru, Lapland, Sicily, and other unlikely places (see articles about them in BEAII and the Exploratorium website under solar eclipses.)

The 1868 solar eclipse as seen from India was particularly important in revealing to a Frenchman (Jules Jenssen) and an Englishman (Norman Lockyer) that you could use a spectroscope to separate out the light from the chromosphere, and that it could be done even without the eclipse (Nath 2013). The discovery of helium, however, belonged to Lockyer alone. And, looking ahead to the end of the next section, we can see that, of the astronomers who went to Sobral and Principe to test General Relativity, Eddington himself was the only chap attending his first eclipse.

The 1911 founding of the AAVSO of course belongs to the end of this (relatively) peaceful long 19th century. Variable star observing in the U.S. goes back considerably further (Saladyga 1999, who indicates that more detail is to be found in Williams and Saladyga 2011), but was initially hampered relative to European work by the non-availability of Argelander's *Uranometria Nova* (a catalogue of 3,500 northern stars from his own observations). While we have Argelander with us, it should be mentioned that he was a founder of the modern version of the Astronomische Gesellschaft in 1863 and organized 13 observatories in multiple European nations to get precise positions of all northern stars down to the 9th magnitude in his *Bonner Durchmusterung*. Completion of the 15-volume resulting AGK (*Katalog der Astronomischen Gesellschaft)* came in 1910.

Meanwhile, as it were, Benjamin Apthorp Gould, the first American astronomer trained in Europe, had visited Paris and London, picked up a doctoral degree in Göttingen, and visited Altona, home of Heinrich Schumacher, founder of *Astronomische Nachrichten*. Gould brought that idea back home as well as some star catalogues, founded *The Astronomical Journal* in 1849, got into a frightful mess in connection with Dudley Observatory, and went off to Argentina from 1870 to 1885, bringing back the plates whose eventual measurement led to the *Cordoba Durchmusterung* (T. E. Bell in BEAII, p. 833). His long-term indirect influence on Seth Chandler (who also visited Argelander in Germany), E. C. Pickering, and William Tyler Olcott also fed into the founding of the AAVSO by the third of these.

A mostly national rather than international organization, the AAVSO happily survived the organizational massacre of 1914–1919 under Olcott's secretaryship, holding its first regular meeting at Harvard College Observatory in 1915 and being incorporated in 1918 (M. Saladyga in BEAII, p. 1608). About half the Association's members are now resident outside the U.S., according to the AAVSO website.

Indeed it seemed that internationalism experienced a major growth spurt as the long century drew to a close. After meeting in Rome in 1884, the International Geodetic Association held its Washington Conference in 1885 establishing time zones (essential for railways!) with longitude 0º at Greenwich (A. R. Christie the Astronomer Royal at the time thought it best not to go to the latter meeting). According to Emerson (2013) there were, between 1900 and 1913, 426 international meetings in Paris, 168 in Brussels, 141 in London, 96 in Berlin, and a mere 14 in New York. All this came to a precipitous end with the guns of August. Astronomers were far from the only scientific sufferers. The international Association of Chemical Societies first met in Paris in 1911 and gave high priority to rationalizing the names of organic compounds and producing a fourth edition of Beilstein's catalogue. Paul Jacobson, former professor at Heidelberg, had just established a commission to get to work in the summer of 1914. When the International Union of Pure and Applied Chemistry took over the tasks in 1919, Germans were not permitted, so Jacobson was lost to the projects, and Freidrich Beilstein would not have been allowed to work on his own catalogue if he had still been alive (Heppler-Smith 2015).

4. A deep relative minimum: 1914–1919

For astronomers, The Great War to end all Wars began with the capture of an Observatory of Berlin solar eclipse expedition under Erwin Freundlich to the Crimea in August 1914. The expedition was partly financed by the Krupp family, and the primary goal was to look for bending of starlight by the sun. They had been urged to do this by Albert Einstein (Halpern 2015) who was then expecting a value near 0.8" at the solar limb, as you can calculate for yourself, using Newtonian mechanics and a particle theory of light. Although Freundlich himself was quickly traded for a Russian prisoner of war held by the Germans, August Kühl (1916) was held for more than a year, and the equipment was never recovered. Halpern has speculated on the possible outcome if the measurement had been made, because they would presumably have found about twice the value they were expecting. Freundlich participated in other eclipse expeditions later, found a value larger than the general relativistic prediction of 1.86" at the limb, and remained somewhat out of step with the rest of the astronomical community the rest of his life (H. Kragh in BEAII, p. 757) Alan Batten, who knows a great deal about binary and variable stars, was a student in some of Frendlich's classes as an undergraduate at St. Andrews.

A very large number of physicists, astronomers, and other scientists served in a wide variety of capacities through World War I. My list of just astronomers and those in closely related sciences is three single-spaced pages, mostly survivors like Erwin Schrödinger and Rudolph Minkowski on the Austrian-Italian and German-Russian fronts, respectively. I knew only the latter, who refereed, gently and helpfully, the second paper that came out of my Ph.D. dissertation. Those killed were mostly too young to have made their reputations. But we remember Karl Schwarzschild, an over-age volunteer, who died of pemphigus (an autoimmune disorder) very soon after he wrote his famous paper on the "black hole" solution of Einstein's equations, and also Henry Moseley, of atomic weights (a young volunteer), and the younger son, Robert, a budding geologist, of Sir William H. Bragg the 1915 Nobelist. The latter two were among the 44,000 U.K., Australian, and New Zealand troops killed at Gallipoli. The Ottoman casualties were nearly double that at 84,000 and must surely also have included potential future outstanding scientists. According to a recent advertisement, Gallipoli is now a tourist destination.

The end came in 1919, with eclipse expeditions to Principe and Sobral, once again intended to look for bending of light, this time at the modern GR level, and they found it. Primary credit is generally given to Arthur Eddington, who went to Principe and whose "war work" had been planning the expedition, though the Astronomer Royal, Frank Watson Dyson, had also been involved. Himself born in 1868, Dyson remained at Greenwich through the war, continuing work on almanacs and ephemerides, but 36 members of his staff went off to war, not all to return, and were replaced by conscientious objectors, retirees, Belgian refugees, and women (J. Tenn in BEAII, p. 629). Charles Davis and Andrew Crommelin (b. 1875 and 1864, respectively) were the actual observers at Sobral, Brazil. The two eclipses, 1914 and 1919, form symmetric bookends to the war.

ARTICLE 131.

Germany undertakes to restore to China within twelve months from the coming into force of the present Treaty all the astronomical instruments which her troops in 1900-1901 carried away from China, and to defray all expenses which may be incurred in effecting such restoration, including the expenses of dismounting, packing, transporting, insurance and installation in Peking.

Figure 3. Article 131 from the *Traité de Paix*.

But we are not yet back on peaceful soil. The year 1919 also saw the founding of the International Astronomical Union under the International Research Council, both with significant input from George Ellery Hale, whose solar Union had been abolished under the treaty of Versailles. The rules were that only "allied countries" and their scientists (the winners) could join in the first instance; neutrals later; and Germany did not adhere to the IAU until after WWII, though by the 1930s the primary barriers were financial. There was much bitterness over these restrictions in the (neutral) Netherlands, especially from Kapteyn, and obviously in Germany, where the astronomers felt that their own Astronomische Gesellschaft, with half its pre-war members non-German, was the appropriate international organization (Blaauw 1994).

The previous paragraph requires some clarification. Astronomy is mentioned in the *Traité de Paix*, an authentic, first-edition copy of which purchased recently at auction now lies on my desk, but only in Article 131 (Figure 3). Article 282 provides a list of 26 previously-existing "multilateral treaties, conventions, and agreements of an economic or technical character" allowed to survive. Hale's International Union for Solar Research is not there, though the International Agricultural Institute at Rome is. Many of the rest deal with health and safety issues, standardization (including concert pitch), and the metric system. They date from between 1857 and 1910.

The words I was looking for, however, come from Article I of the resolutions adopted at the Conference of London, October 1918, and are duplicated in the statutes of the International Astronomical Union, and quoted in Chapter I of Blaauw (1994):

> That it is desirable that the nations at war with the Central Powers withdraw from the existing conventions relating to International Scientific Associations in accordance with the Statutes or Regulations of such Conventions respectively, as soon as circumstances permit. (and)
>
> That new associations, deemed to be useful to the progress of science and its applications, be established without delay by the nations at war with the Central Powers, with the eventual cooperation of neutral nations.

Figure 3 shows Article 131 of the 1919 Treaty of Versailles, in which Germany agrees to restore to China (transport and installation paid) all the astronomical instruments removed by her troops in 1900–1901. I rather doubt that this ever happened! (Xerocopied from a copy of the *Treaty of Peace*, purchased at auction in 2015, which once belonged to Frank W. Mason. The English text appears on the right hand, odd-numbered pages, and the French text on the left hand, even-numbered pages.) This is the only mention of astronomy in the 428-page volume. The Americans signed first, led by Woodrow Wilson, the British second, led by David Lloyd George, the French third, led by G. Clemenceau, J. van den Heuvel for Belgium (no, I don't know if the astronomer is a relative or descendent), I. J. Paderewski for Poland, and Eduard Benes for Czheco-Slovokia. The Germans were Hermann Muller and Dr. Bell, and Hedjz and Liberia were among the others. Germany was still, just, an Empire, and there were more kings and other titled folk than you would find mentioned today on any hypothetical similar treaty. The United States of America also leads the list of founding members of the League of Nations, though, in the absence of Senate approval, we were never a member. Some of the pages in my copy had not been cut, particularly in the section defining the new boundaries of Germany.

Blaauw tells much more of the story. The last (so far) entanglement of the IAU with political issues was the membership of Taiwan and China from 1959 to 1979, resolved with a decision to have one adhering nation represented by two adhering organizations, one initially located in the People's Republic of China at Purple Mountain Observatory, and one in Taiwan, ratified at the Patras IAU in 1982. Similar history, with the dissolution of the International Association of Chemical Societies in 1919 and the establishment of the International Union of Pure and Applied Chemistry, but with more rapid German consultation, is outlined by Hepler-Smith (2015). They, the International Union of Biochemists, and others welcomed one China with two adhering organizations at about the same time as did the IAU.

On the whole, the purely scientific events gradually improved, though consult Blaauw once more (pp. 12–13 and 16–17) to see that the participants at the Bonn 1913 meeting of the Solar Union look a good deal more cheerful than those at the second IAU General Assembly in Rome in 1922.

5. From war to war

Here it is necessary to distinguish between the winners and the losers. German astronomers gradually took back some of their old tasks of maintaining databases for variable stars and minor planets and the enormously valuable, *Astronomische Jahrsberichte*, but the Central Telegram Bureau remained in Copenhagen and time in Paris. But you can walk along the shelves of any library that still keeps paper copies of journals (if you can find one!) and see that their publication rate was climbing back only very slowly (in physics and chemistry, as well as astronomy) even before the depression hit everyone, but Germany and Austria harder than most.

Meanwhile there is a definite exuberance to the state of astronomy (as well as many other things) in the United States (see Trimble 1995 on the cultural background of the Curtis-Shapley debate). Dorrit Hoffleit (2002), because of her German parents and names, was considered a natural enemy of her playmates in 1917–1918, but firmly advanced to be paid half as much as the men (40 cents/hour) at Harvard College Observatory during the Depression, onward to war work at Aberdeen Proving Ground, partly under Edwin Hubble, and through many triumphs and occasional vicissitudes to have her autobiography published by the AAVSO, of which she had been president in 1961–1963.

Hubble? Didn't we leave him enroute to Europe as a volunteer when the U.S. entered WWI? Yes, and Shapley the same year took up an appointment at Mt. Wilson, carrying out with the 60-inch telescope some of the things that Hubble later said he had planned to do. They would probably not have been bosom buddies in any case (Sandage 2004), but competition for photons did not improve the situation. They diverged also in the second war, Shapley staying put at Harvard and Hubble heading to Aberdeen, Maryland, to work in the ballistic missile laboratory. Of the other stars of the 1920 debate, Hale spent the years 1916–1918 establishing the National Research Council, while Heber Curtis taught navigation and worked in the optical section of the National Bureau of Standards. Harvard under Shapley produced one third of the American Astronomy Ph.D.'s from 1930 to 1940 (Sandage 2004). Caltech produced two (Josef Johnson and Olin C. Wilson), and they were not Hubble's students. Indeed Hubble had none, though Sandage as a Caltech graduate student and George Abell as an undergrad worked with him.

Meanwhile the IAU had grown from 207 members and 19 countries at the Rome General Assembly (1922) to 554 members and 26 countries at the Stockholm General Assembly (1938). But national affairs were beginning to affect international collaborations. The Stalinist purges beginning in 1936–1937 led to the loss of about nine IAU members (Blaauw 1994), of whom the best-known in Europe and America (which is what got him into trouble) was Boris Gerasimovich (K. Haramundanis in BEAII, p. 796).

In the same time frame, astronomers and many others began leaving Germany and, later, Austria because they were Jewish, had Jewish family, or were otherwise displeasing to the authorities. Einstein was the best known (and among the first to leave), Baade moved voluntarily from Hamburg to Mt. Wilson in 1931, and Minkowski (with a Jewish father-in-law) lost his professorship in 1935 and made it to Mt. Wilson soon after (I. T. Dunham in BEAII, p. 1391). Martin Schwarzschild, whose father you met in section 4, despite being the son of a war hero (with a non-Jewish mother), thought it wisest to finish up his Göttingen Ph.D. very quickly in 1935, moving on via Leiden, Oslo (as a Nansen fellow), the U.K., and on to the U.S. in 1937 (Trimble 1997). A number of future astronomers and physicists were among the nearly 10,000 children ages 3–16 who left Germany, Austria, and Czechoslovakia via the Netherlands for Britain in 1938–1939 as part of the Kindertransport. The number indeed seems large compared to the number of physical scientists among the population of any country then or now, so I suppose it must have been some sort of a class distinction that carried over to the next generation.

6. The Second World War and immediate aftermath

Some cultures are said to distinguish three classes of people: the living (whom one insults at one's peril), the far dead (like Tycho, Kepler, and Galileo, about whom you may say what you please, at risk only of your academic reputation), and the near dead (who are still remembered with friendship, blood ties, admiration, or hatred by folks still living, and so about whom you speak or write with caution). The people and events of the Second World War still, just, belong to this precarious near-dead category. I am the widow of a 1940 graduate of the U.S. Naval Academy who was on USS *Lexington* when she steamed out of Pearl Harbor on the 6th of December 1941, had her sunk out from under him at the Battle of the Coral Sea, went on to skipper a submarine chaser back and forth across the Atlantic a number of times, and participated in the Sicilian landing. But he later had close scientific collaborations with Japanese and Italian colleagues and somewhat more cautious ones with German physicists and astronomers.

That being said, the main cause of World War II was World War I and the incredible provisions of the Treaty signed at Versailles on June 28, 1919, by 60 men from five Allied Countries, 22 Associated Countries, and Germany. The required "reparations" exceeded the income of Germany by some sizable factor, and she was expected to get permission from Allied Commissions to repair her railroads, dredge her canals, and even less seemingly-other-regarding activities. There were also consequences for Austria, Hungary, Italy, Turkey, and Denmark, though they were not signatories but were covered by other, later treaties.

The sum total of slaughter and suffering was, as during the first war, beyond description, though again the "horror weapon" (atomic bomb) was not the main killer, as poison gas had not been in the first war. Book-length treatments (Hastings 2015; Beevor 2015) continue to appear, which you can peruse for accounts of cannibalism and all the rest (though little mention of science per se except as a weapon in the form of radar, rockets, and bombs). On a personal level, Blaauw (2004) noted that, of his group of six close friends at Leiden Observatory, two became famous (Blaauw himself and Wesselink of the Baade-Wesselink method for measuring Cepheid distances), one spent the war as a high school teacher, and three died in Indonesia as Japanese prisoners of war.

As for the IAU, battle lines quickly separated the British president (Eddington, who was to die in 1944), the Dutch secretary (Oort), and vice presidents in Italy, Poland, Sweden, France, Switzerland, and the United States. Walter S. Adams at Mt. Wilson became the secretary. Remarkably, the collection of national dues and support of ongoing projects continued to take place separately in the blocks of countries held by Germany and by the opposition ("allies" at this point is an excessively charged word!)

In some ways, at least, the war-engendered ruptures healed faster than after the first war. The surviving members of the IAU executive committee and other distinguished astronomers met in Copenhagen in March 1946 at the invitation of Ellis and Bengt Strömgren (father and son). The obvious winners, plus Czechoslovakia, Poland, and Russia were represented; Germany and Japan were not, and the initial proposals for new commission members included no one from those two major losers. Abetti from Florence, Italy, however retained his vice-presidency. An exceedingly large number of issues were discussed informally over the next two years and ratified at the 1948 General Assembly in Zurich (Blaauw 1994).

Some of the specifically international items were: (1) establishment of new commissions on international observatories and exchange of astronomers (among member nations). (2) Prager had died in 1945, and the Belin-Babelsburg Observatory was not in a position to continue cataloguing, naming, and collecting data on variable stars, so the task was handed over to B. V. Kukarkin and P. P. Parenago in Moscow. (3) Many other tasks that had been historically German were spread out among Potsdam (East Germany/DDR), Heidelberg (West Germany/DBR), Cincinnati, and Leningrad. (4) The enormously valuable *Jaharesberichte*, suspended after 1940 but with supplemental efforts in France, also ended up in Heidelberg, with publication shifting to Springer Verlag in 1969 under the title *Astronomy and Astrophysics Abstracts*, only recently discontinued. (5) And yes, Germany was admitted and Japan (a 1919 founding member) readmitted to Union membership at the 1952 General Assembly at Rome (the same one where Baade cut Hubble's constant in half and so doubled the length scale and age of the universe). That 1952 General Assembly replaced one previously scheduled for 1951 in Leningrad, a victim of the gradually-rising tensions of what was soon named the Cold War, though Americans went to Moscow in 1958 and Russians to Berkeley in 1961. 1964 was held in Heidelberg, recognizing the healing of that rift, at least for people too young to remember.

But let us end this section on a note of at least moderate astronomical cheer. The United Nations has never drawn unqualified praise (though more than the League of Nations, whose charge is part of the 1919 Peace Treaty). But UNESCO (the United Nations Educational, Scientific, and Cultural Organization into which Shapley is said to have inserted the S) became a supporter of the IAU projects to the tune of $49,884 over 1948–1951, nearly equal to the sum of national contributions through the same period. The money paid for many projects of the individual Commissions and the central Bureau, which in those days moved after each General Assembly to the home of the new General Secretary.

At least three other (mostly) good things came out of the war: (1) engineers (etc.) with radar dishes pointed them up and became radio astronomers (some German dishes having been moved to England and Holland for the purpose); (2) captured V-2 rockets and rocketeers began carrying UV and X-ray detectors above the atmosphere, seeing, first the sun (Hufbauer 1991), and, in modified form, Sco X-I and the Crab Nebula; and (3) people, both those forced immigrants of 1933–1945 and after, and those honed in the Manhattan Project, turned much of their attention to fundamental problems in physics and astronomy. Development of computers (now meaning machines rather than women paid at most 40 cents per hour!) should probably also be counted among the pluses.

Widespread destruction in Europe, Japan, China, and elsewhere, coupled with outstanding observing sites in the United States and rapidly-developing computational equipment and skills at Los Alamos, Lawrence Radiation Lab, and elsewhere, meant that post-war leadership in astronomy moved firmly to the United States. The rest of the world has at least caught up since then.

7. Now and into the future

It is somehow fitting that, since both World Wars started as European disputes, Europe has moved furthest toward integrating many things today. The first large pan-European organization was CERN (The European Organization for Nuclear Research), established with help from UNESCO. Its structural plan was sound enough that many aspects of the European Southern Observatory were modeled on it (Blaauw 2004; Woltjer 2006), though it all took some time. Discussions started in 1953, the requisite treaties were signed in 1962, and "first light" at La Silla came in 1966 with a 1-meter reflector. The situation has since improved enormously. The five founding partners, Belgium, France, Germany, the Netherlands, and Sweden, have expanded to 17, including Brazil and covering the map of western Europe with little holes for Ireland, Norway, and Luxemburg. The merging of a handful of national journals into *Astronomy and Astrophysics* in 1969 has been almost as successful, and now involves a larger number of countries, paper being cheaper than optical-quality glass.

Other ongoing successes have included the European Very Long Baseline (radio) Interferometer (which now extends Eastward to China) and the European Space Agency (ESA), a yet slightly different partnership that began life as ESRO (European Space Research Organization) with an Austrian-English Jewish director, Sir Hermann Bondi.

Space and even ground-based facilities have become so expensive that many of the most productive now and in the future will extend past these "small" international collaborations to take in all of Europe, much of Asia, the United States, Australia, and Canada, and non-governmental partners, universities, foundations, and commercial organizations. The Hubble Space Telescope, an early ESA-NASA partnership, has set a standard for this sort of thing. ALMA, the now-nearly-complete Atacama Large Millimeter Array, involves Europe, the U.S., Canada, Japan, and, of course, Chile, where it is located. The 20–40-meter class optical telescopes planned for the next decade—E-ELT (European Extremely Large Telescope), TMT (Thirty Meter Telescope), GMT (Giant Magellan Telescope), and the radio SKA (Square Kilometer Array) will bring in many countries, including China, that have not previously been partners in world-wide astronomy. I find particularly hopeful plans for an East Asian telescope involving China, Japan, Taiwan, and South Korea, with some input from Chinese-American astronomer Ron Taam (2015). Parts of SKA will also involve South Africa and Australia, and H.E.S.S. (High Energy Stereoscopic System—a high energy gamma-ray detector) is in Namibia.

The U.S. attitude could still use a little fine tuning. A prepublication copy of *New Worlds, New Horizons* (National Research Council 2010) says (p. 3–4) "nearly all of this report's ranked recommended projects have opportunities for contributions—often substantial—by foreign partners." The very long lead times, costs, and disagreements on priorities are tempting ESA and NASA to try once more to go it alone, with unavoidable loss of capabilities of the missions.

There is now so much going on that everything you pick up is likely to have an item relevant to international astronomy successes (or failures), or light as a symbol of something good or as a pollutant for astronomy as well as wildlife. Here are a very few to check and decide for yourself whether they belong on the plus or minus side.

• Li *et al.* (2015) on magnetic fields in star forming regions has authors from Hong Kong, Beijing, Taipei, Nanjing, and Harvard.

• SESAME, a synchrotron light source being constructed in Lebanon, is a collaboration involving the Palestinian Authority, Israel, and about a dozen other Middle Eastern nations (Winnick 2015).

• Construction of the Large Synoptic Survey Telescope has been in happy partnership with Chile, its host; the construction of the Thirty Meter Telescope on Maunakea has been interrupted (at best) by lack of agreement between the many partners (Americans and international) and the descendants of the citizens of the former nation hosting it. By the way, Mauna Kea is "a white mountain," while Maunakea is "the white mountain," and is the form preferred by the locals.

• The European Association for Chemical and Molecular Sciences organized a 3-day conference on the 22 April 2015 (centenary of the first extensive use of chemical weapons) to discuss how to improve international laws to prevent the future use of such weapons. Where was the conference? Ypres, Belgium, of course.

• A spread on "The Next Great Exoplanet Hunt" (Heng and Winn 2015) characterizes 4 prospective missions as pure ESA (CHEOPS, PLATO) or pure NASA (TESS, Kepler2). Don't try to remember the names; they will all have changed many tines before anything flies. The article is also wrong about the main reason that apparently bright stars are much less common than apparently faint stars.

• A Swedish colleague has just called my attention to a published use of the phrase "dunkle materie" by Knut Lundmark (1931) with a fairly good estimate of the amount in a couple of galaxies. Notice that 1931 is before 1933, and yet Fritz Zwicky is virtually always given credit for the German phrase, because search engines do not easily find the Swedish paper.

• The next few space detectors for gamma-rays will come neither from ESA nor from NASA but from approved Chinese (2) and Russian (1) planned launches for about 2020 (Bergstrom 2015).

• The Nuclear Science Advisory Committee (advisory to the

U.S. Department of Energy) has put as its first priority either turning the Relativistic Heavy Ion Collider (Brookhaven National Laboratory, Upton, New York) or the Continuous Electron Beam Accelerator Facility (Newport News, Virginia) into an electron-ion collider to maintain an American "world leadership position." But folks not on the committee say it cannot be done without international buy-in, as has also turned out to be necessary for the Long Baseline Neutrino Experiment. Each of them, when/if, will yield results useful for astrophysics and cosmology.

• The International Dark Sky Association has found a few places to declare successfully dark sites, and not just because of tanking economies (the surest way to darken skies). But I think probably that even the U.S. can learn to become as international as Schröter's and von Zach's "celestial police" and as international as world conditions will let us be.

8. Acknowledgements

I am indebted to AAVSO Director Stella Kafka and *JAAVSO* Editor John Percy for the invitation to assemble this oddly-motivated assortment of items from the history of astronomy and related fields; to Dennis Danielson and Owen Gingerich for permission to use maps from their books; to Robert Cumming of the Onsala Space Observatory for transmission of the Bergstrom presentation and the Lundmark paper (in proper German); to editor Michael Saladyga for fine-tuning the text and references; to the late Frank W. Mason, the original owner of my copy of the 1919 *Traite de Paix*; and especially to Alison Lara for her, as always, excellent transformation of a typed original into a submittable keyboarded script.

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