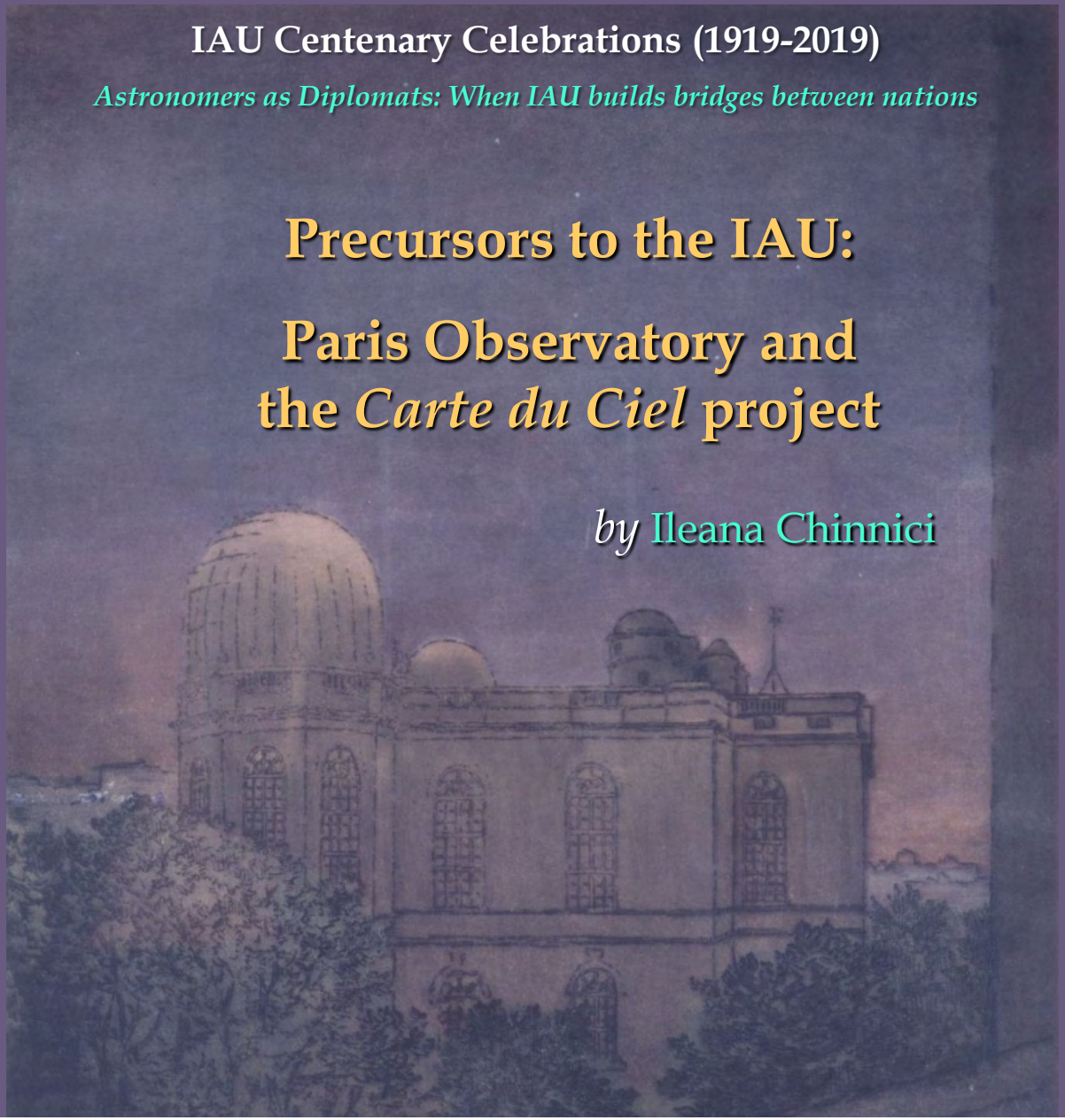
IAU Centenary Celebrations (1919-2019)

Astronomers as Diplomats: When IAU builds bridges between nations

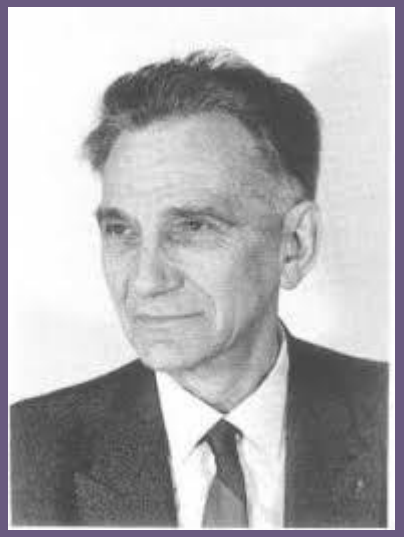
Precursors to the IAU:

Paris Observatory and the *Carte du Ciel* project

by Ileana Chinnici



INAF - OSSERVATORIO ASTRONOMICO DI PALERMO
"Giuseppe Salvatore Vaiana"



L'entreprise de la Carte [du Ciel a] jeté les bases de la coopération internationale dans la science …

(*The Carte du Ciel enterprise has established the foundations of the international scientific cooperation …*)

(P. Couderc, Brighton IAU GA, 1970)

Some early attempts of Scientific Cooperation in the 19th century

- Liliental Society (1800) – Survey of ecliptical charts
- Astronomische Gesellschaft (1863) – AGK
- Italian Spectroscopical Society (1871) – Solar monitoring

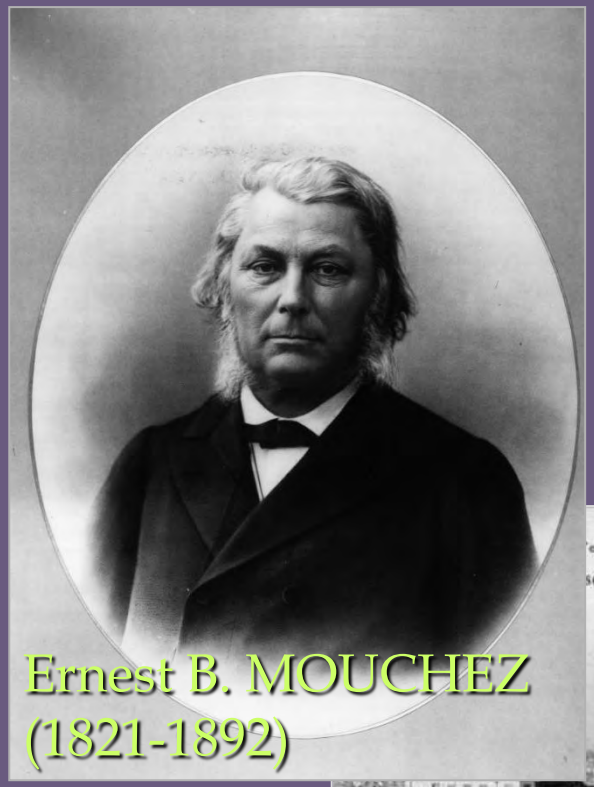
(International Committee on Solar Research, 1904)

Photography and Spectroscopy
(many data, need of a cooperative approach)

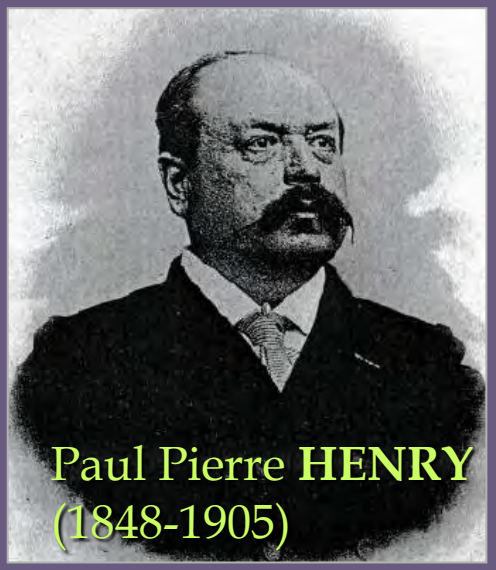
Pioneers in astronomical photography …

- Warren De la Rue (1815-1889) UK
- Angelo Secchi (1818-1878) Italy/Vatican
- Henry Draper (1837-1882) USA
- David Gill (1843-1914) South Africa
- Jules C. Janssen (1824-1907) France

Pioneers in astronomical photography …

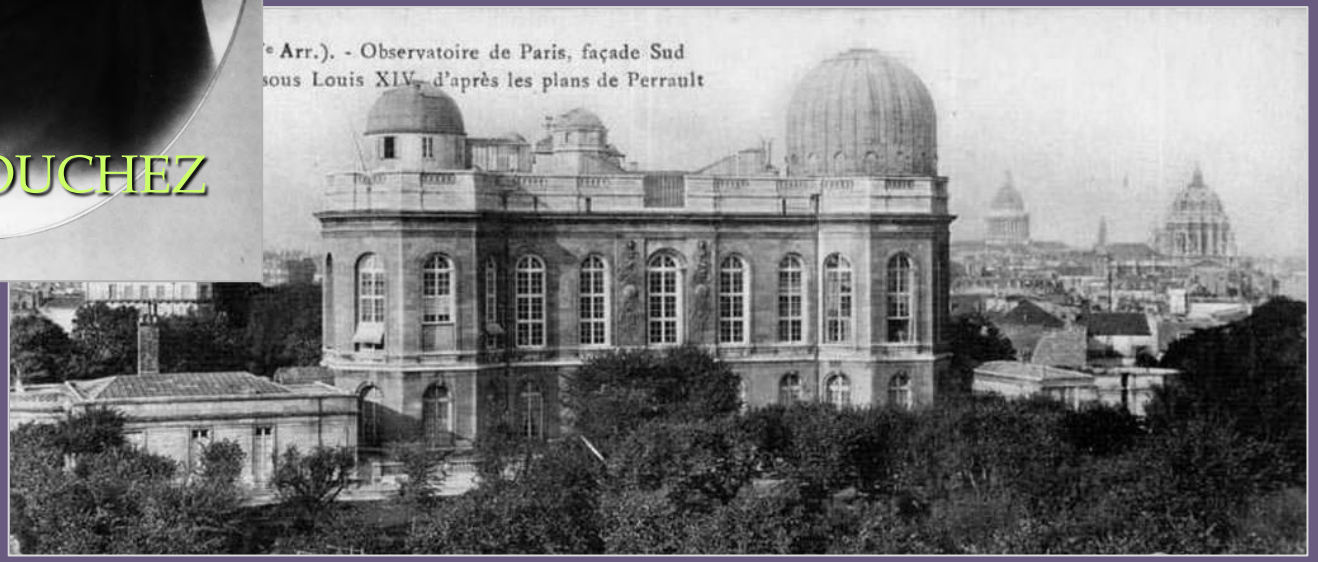


Ernest B. MOUCHEZ
(1821-1892)



Paul Pierre **HENRY**
(1848-1905)

Prosper Mathieu
HENRY (1849-1903)



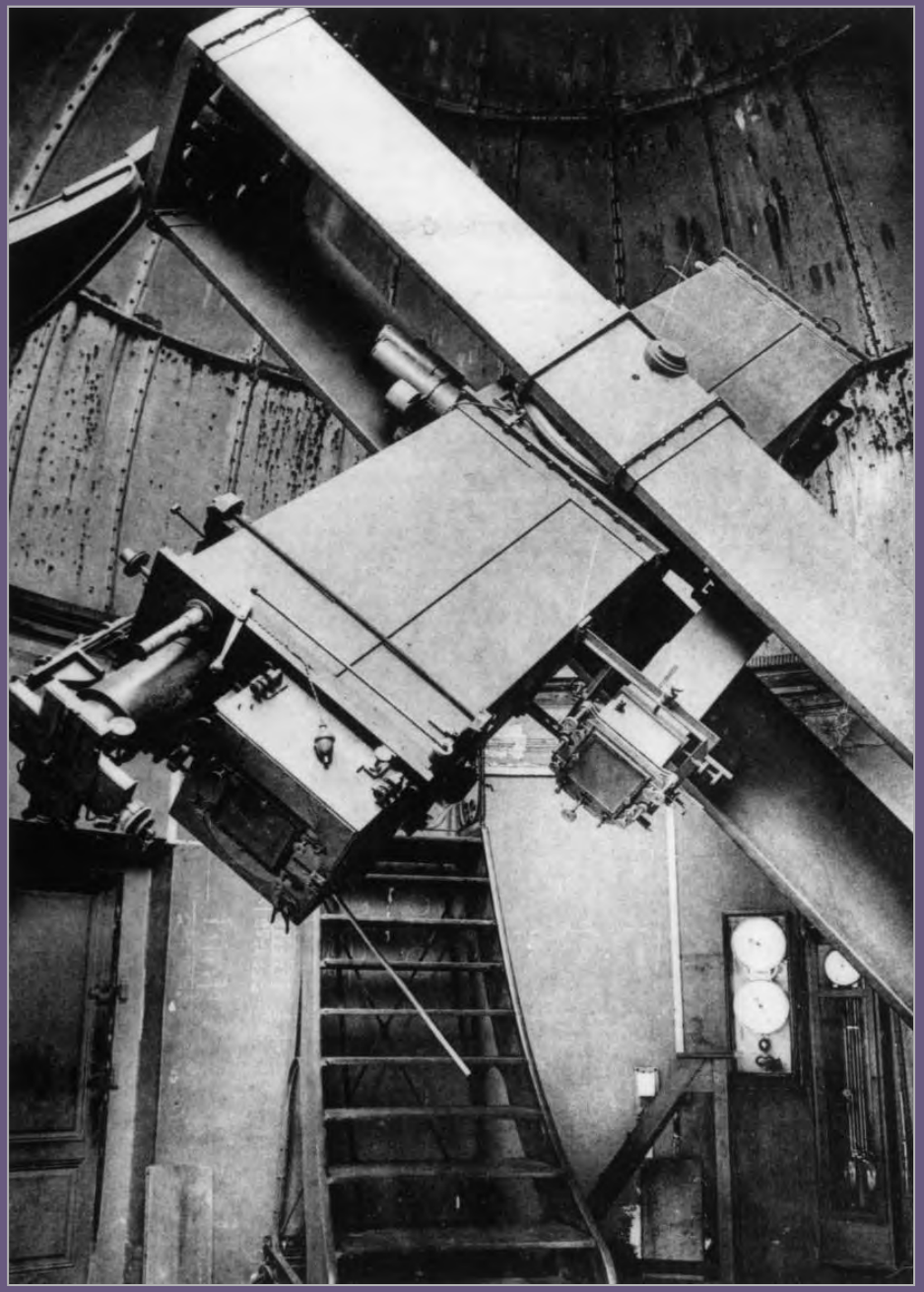
ASTROGRAPH HENRY-GAUTIER

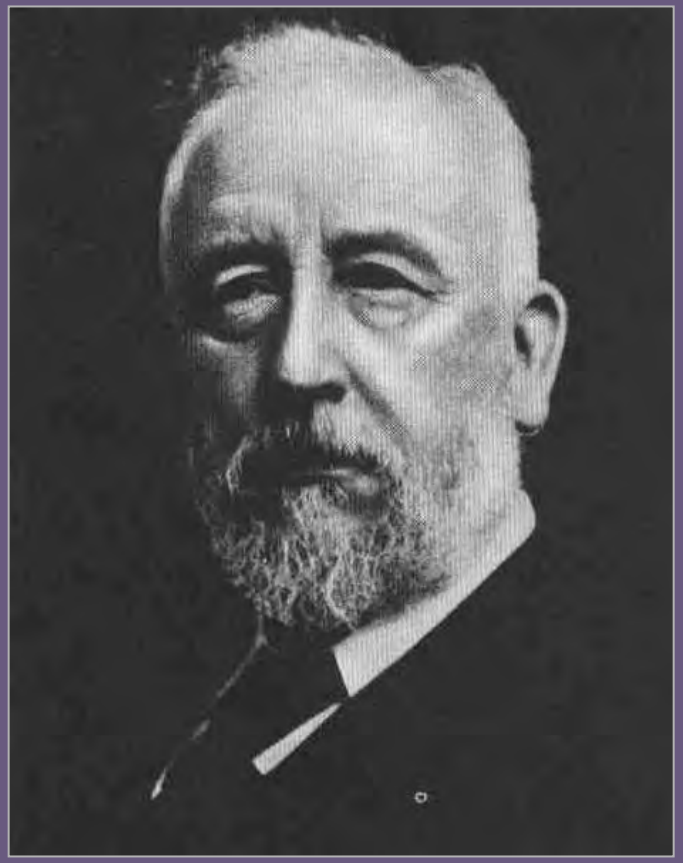
Photographic lens:

aperture= 33 cm
focal length = 343 cm

Visual lens:

aperture= 24 cm
focal lenght = 360 cm

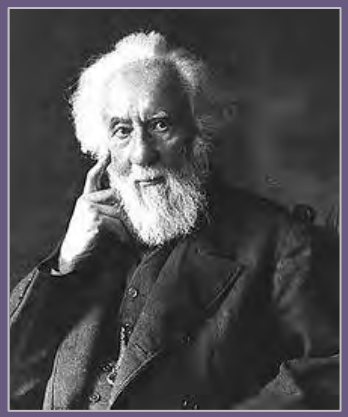




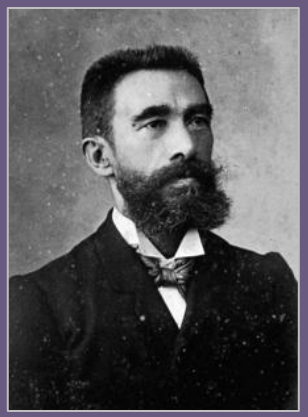
I propose to make a complete and uniform series of Photographic Maps of the Southern Heavens, making also a Catalogue of approximate places and magnitudes from these maps.

(Gill to Mouchez, 1885)

Pickering (USA)



Huggins (UK)



Cruls (Brazil)

Struve (Russia)

OBSERVATOIRE
DE
PARIS

Paris, le 26 Juin 1885

Lettre
Envoyée le 26 juin 1885 à M. Pickering
— id — à M. Huggins.
le 15 Juillet 1885 à M. Cruls.
— id — à M. Struve.

Mon cher Monsieur [illegible]

Je vous envoie une épreuve photographique obtenue dans la voie lactée avec notre nouvel appareil construit par Gautier et muni d'un objectif de 0m,34 achromatique pour les rayons chimiques construit par MM. Henry. En une heure de pose, nous obtenons toutes les étoiles jusqu'à la 15e grandeur sur le cliché et jusqu'à la 14e pour la reproduction sur papier. Les images sont d'une netteté parfaite et proportionnelles à la grandeur des étoiles.

Cette épreuve représentant une superficie de 7 degrés carrés, il en faudrait 6000 semblables pour toute la voûte céleste, qu'on pourrait réunir en 1500 cartes en adoptant la dimension de nos cartes ecliptiques.

La carte photographique du ciel est donc devenue aujourd'hui facilement exécutable si 5 ou 6 observateurs bien choisis dans les deux hémisphères, peuvent s'entendre pour entreprendre ce vaste et si important travail. Elle pourrait être exécutée en 6 ou 8 ans et nous laisserions aux astronomes de l'avenir un état exact de notre ciel à la fin du 19e siècle qui figurerait 30 ou 35 millions

d'étoiles.

Il est facile d'imaginer l'extrême importance d'un tel travail et les découvertes d'un si haut intérêt qui pourraient en résulter. On peut citer, entre autres exemples, la découverte des astéroïdes [illegible] qui viendraient se révéler sur les clichés sous la forme d'un petit trait donnant la vitesse et la direction du mouvement de l'astre pendant 1 heure, comme nous l'avons obtenu pour Pallas.

Je serais heureux si vous vouliez bien étudier un moment cette question et me faire connaître votre opinion.

Veuillez agréer, mon cher Collègue,

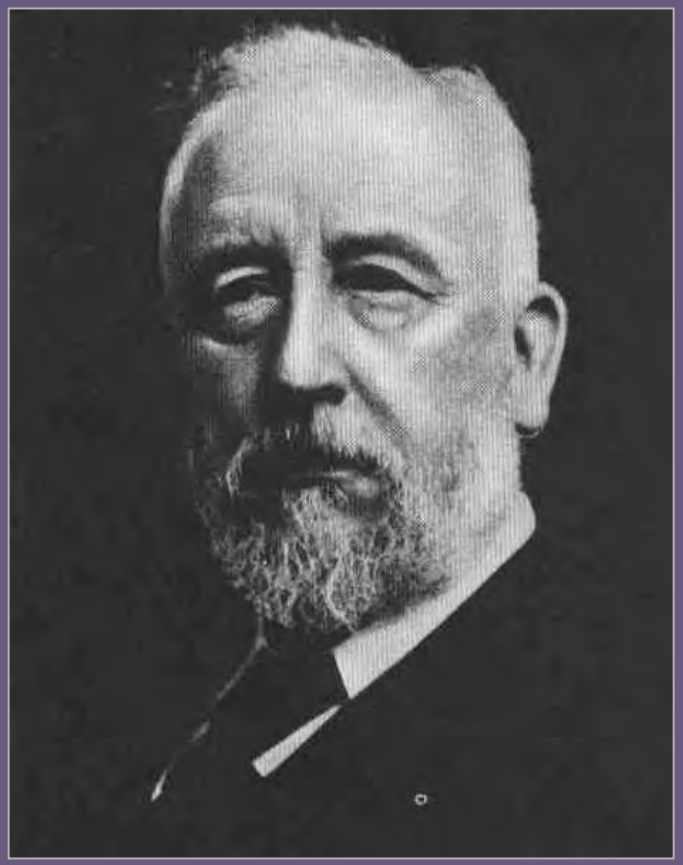
… I send you a photographic plate of the Milky Way obtained with our new instrument [*Henry-Gautier Astrograph*] …

In one hour exposure, we obtain all stars up to magnitude 15 on plates and 14 on paper …

Since the plate covers a sky area of 7 square degrees, we would need **6 000 plates to cover the entire sky vault …**

The photographic sky chart is today easy to achieve if 5 or 6 observatories well positioned in both hemispheres agree to carry out this extended and important work. It could be completed in 6 or 8 years et we shall leave to future astronomers the exact representation of our sky at the end of the 19th century, **with 20 or 25 millions of stars.**

(Mouchez to Pickering, Huggins, Cruls and Struve, 1885)



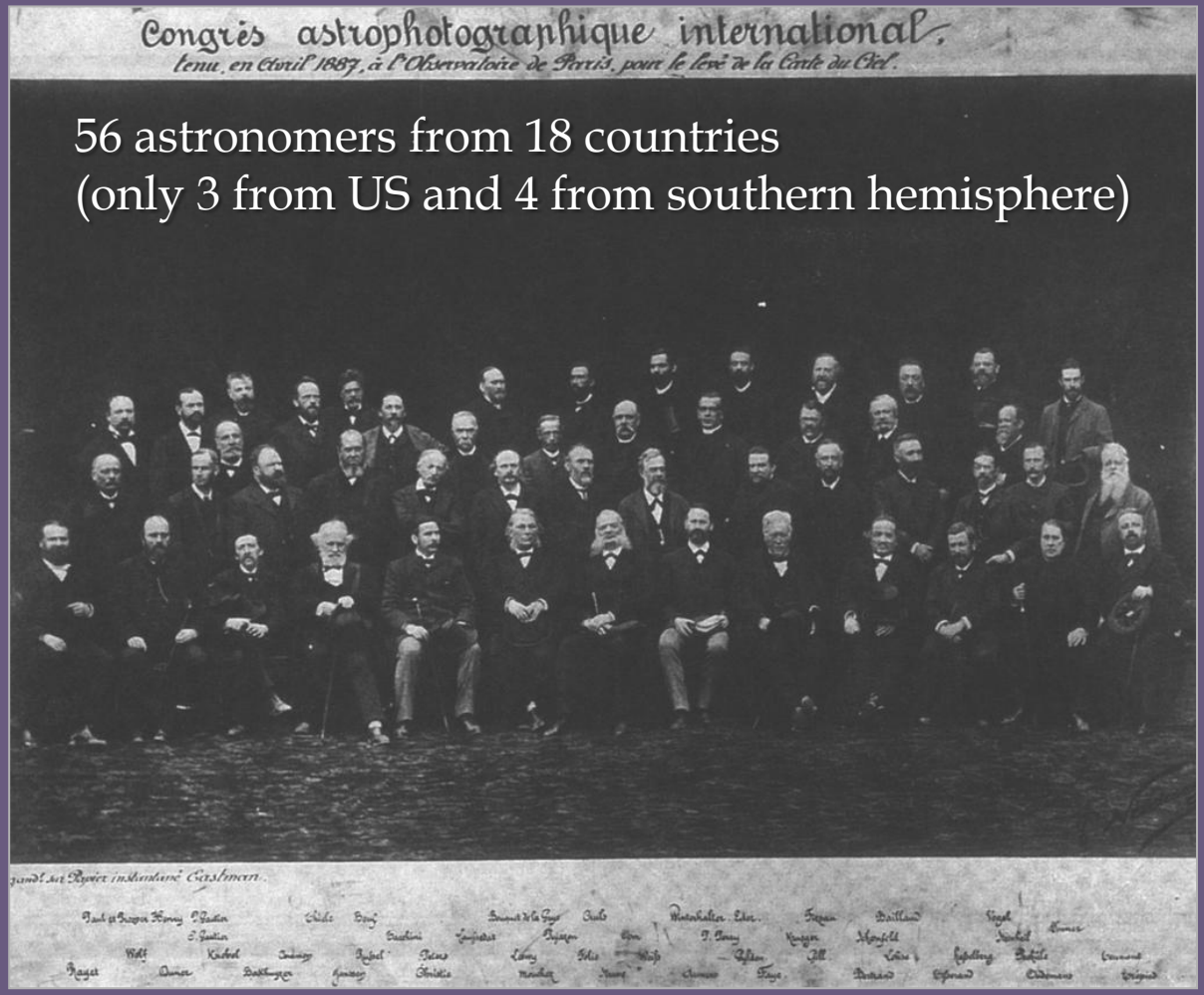
… star charting […] must be begun on a plan carefully preconsidered in every detail and carried out by instruments and methods as far as possible absolutely identical.

(Gill to Mouchez, 1886)

… I think it would be essential to have a Conference and I would be glad to attend such a conference at Paris in March or April 1887.

(Gill to Mouchez, 1886)

First Astrographic Congress (Paris, 1887)

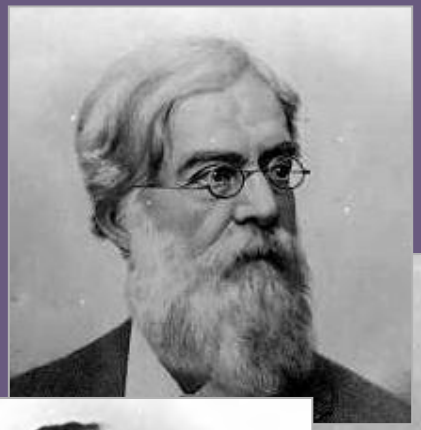


- Permanent International Commission

(11 members + Directors of participating Observatories)

- Executive Committee (9 members)

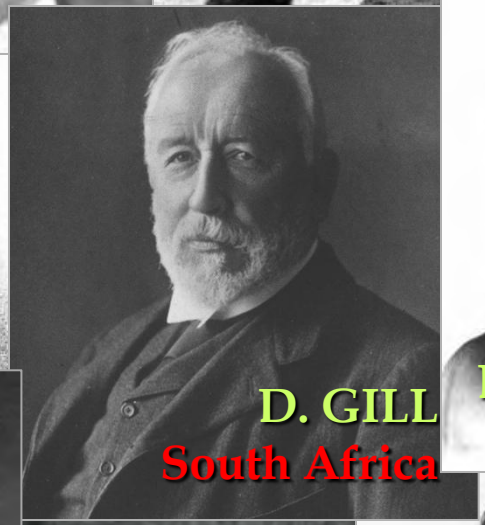

N. C. DUNÉR
Sweden

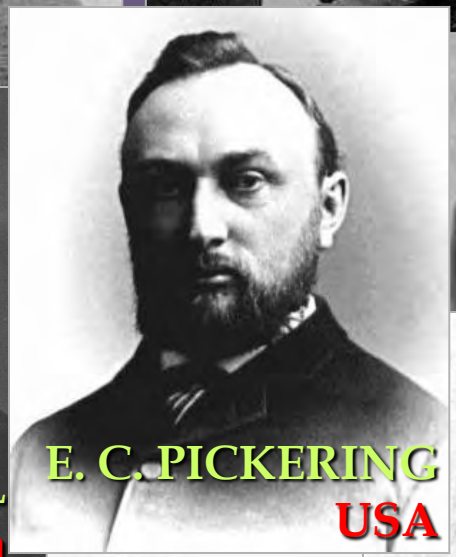

E. WEISS
Austria


W. H. CHRISTIE
UK

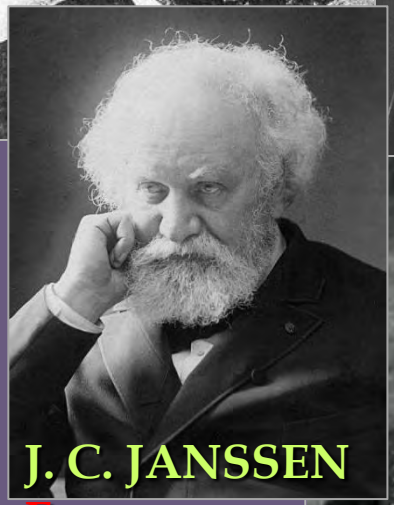

P. TACCHINI
Italy


Pr. HENRY
France

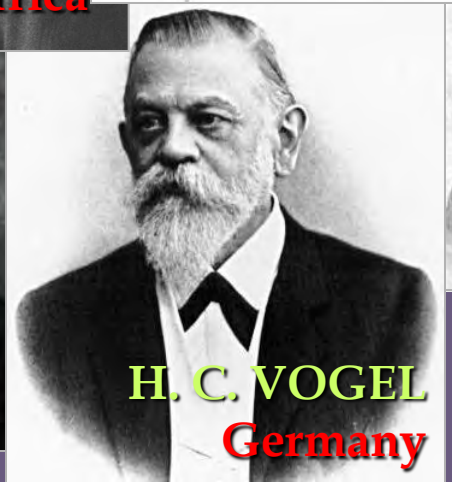

D. GILL
South Africa

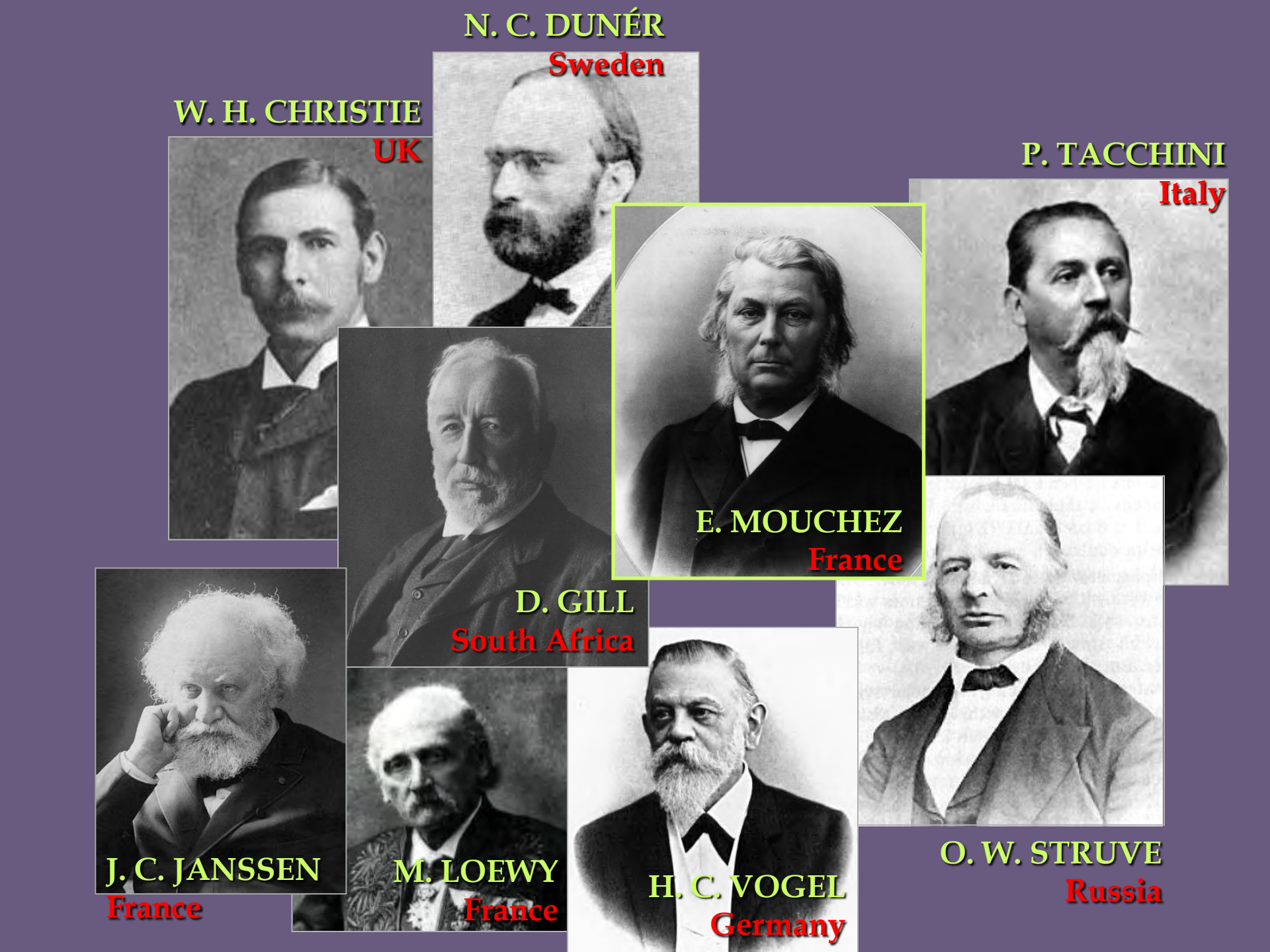

E. C. PICKERING
USA

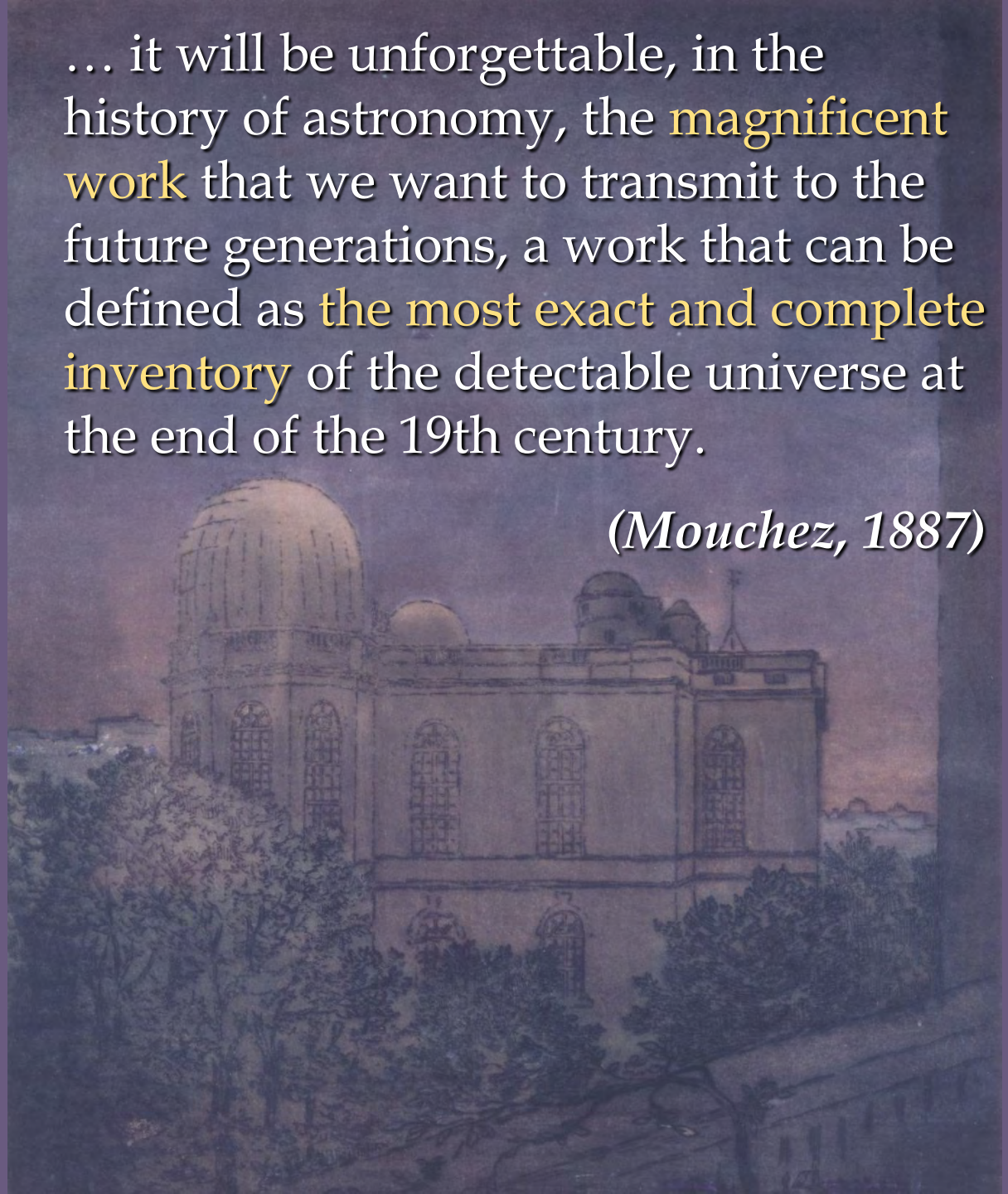

O. W. STRUVE
Russia


J. C. JANSSEN
France


M. LOEWY
France


H. C. VOGEL
Germany


N. C. DUNÉR
Sweden
W. H. CHRISTIE
UK
P. TACCHINI
Italy
E. MOUCHEZ
France
D. GILL
South Africa
J. C. JANSSEN
France
M. LOEWY
France
H. C. VOGEL
Germany
O. W. STRUVE
Russia



… it will be unforgettable, in the history of astronomy, the magnificent work that we want to transmit to the future generations, a work that can be defined as the most exact and complete inventory of the detectable universe at the end of the 19th century.

(Mouchez, 1887)

ORIGINAL PROJECT (1887):

CARTE DU CIEL

CHART

Magnitude limit: 14

30-40,000,000 stars

22,000 plates

17-18 Observatories

field: 2° x 2°

scale: ~ 1 arcmin/mm

Estimated duration: 6-8 years

ORIGINAL PROJECT (1887):

CARTE DU CIEL

CHART

Magnitude limit: 14

30-40,000,000 stars

22,000 plates

17-18 Observatories

field: 2° x 2°

scale: ~ 1 arcmin/mm

Estimated duration: 6-8 years

Catalogue

Magnitude limit: 11

4,000,000 stars

22,000 plates

150-500 stars per plate

200-400,000 measurements

Estimated duration: 25 years

Reference catalogue: 60-70,000 reference stars

CARTE DU CIEL

BEST CATALOGUES/ATLASES OF THAT TIME

Bonner Durchmusterung (1863, AG 1867)

(Argelander, 300,000 stars)

Uranometria Argentina (1879-1884)

(Gould and Schoenfeld, 130,000 stars)

ASTROGRAPH HENRY-GAUTIER

Photographic lens:

aperture= 33 cm
focal length = 343 cm (5,500 FF)

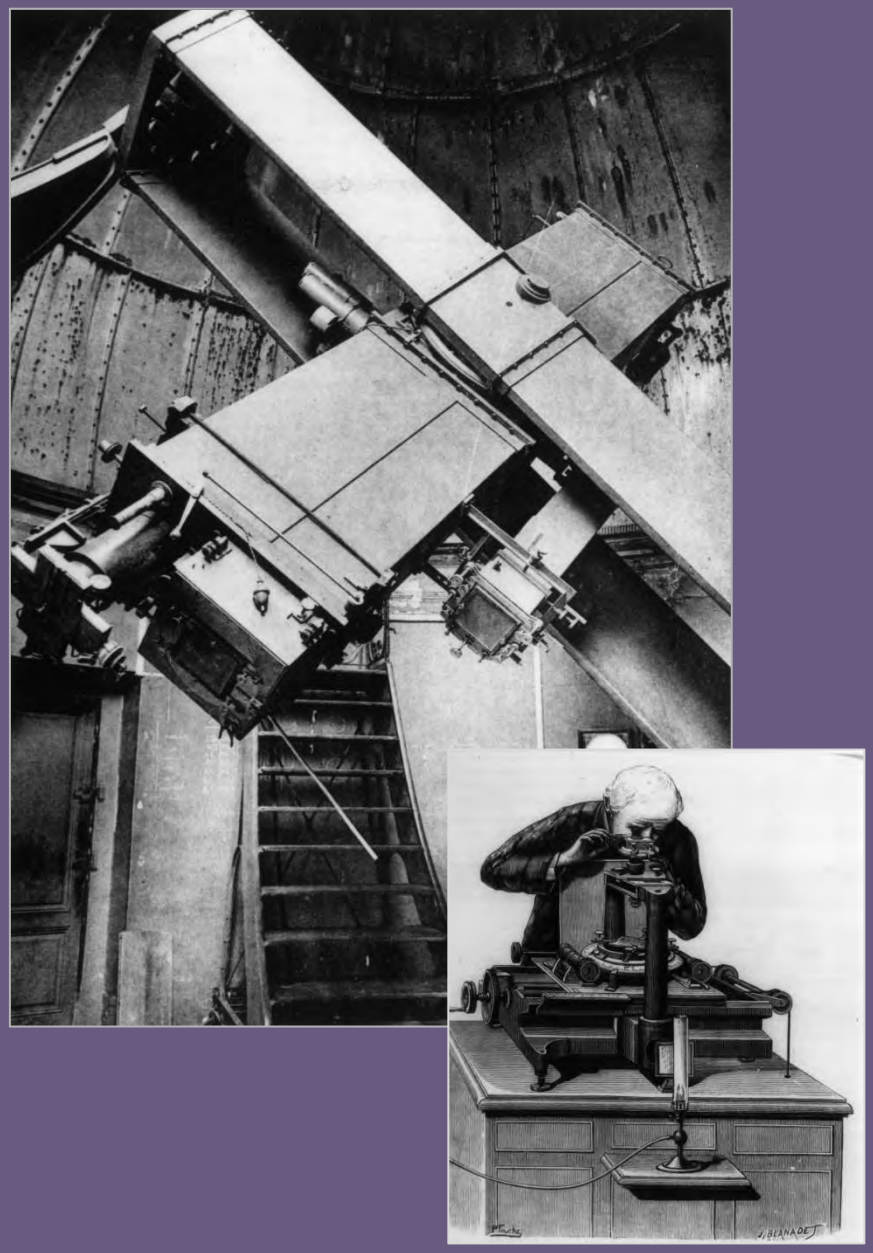
Visual lens:

aperture= 24 cm
focal lenght = 360 cm (1,500 FF)

Mounting (22,000 FF)

Macromicromètre (6,000 FF)

TOT. : 35.000 FF



RESOLUTIONS OF THE PERMANENT INTERNATIONAL COMMISSION:

1889:

- Sizes of the plates (16 x 16 cm)
- Free selection of manufacturers
- Grid impression on chart plates
- Double exposure for the clichés of the Catalogue
- Establishment of a «Bureau des Mesures»

I think you will find that **the point capital will become not *la carte photographique du ciel* –** in the sense of so many photographic plates of the sky – that will become effete long before the work is finished – and Pickering with his 24inch-£ 10,000 double objective lens of 11-feet focus and plates 5° x 5° will have superseded entirely a little work of that kind. **It is the Catalogue,** the organization for its execution, computation and publication which must cause the Astrophotographic Congress of Paris to be **an Epoch in the History of Astronomy.** That must be kept in vue if the Committee desires to fulfill its functions in the most complete manner.

(Gill to Mouchez, 1889)

We consider that the scope of the work has been illegally magnified, and a catalogue illegally substituted for a chart; and the meaning of the word illegal is that the decisions of the Committee on these points are, in our opinion, contrary to those of the real legislative body – the Congress of 1887 …

The Committee is largely composed of those who have hitherto been professionally engaged in making catalogues, and who may thus naturally have a prejudiced view of their importance, while the Congress gained in breadth of view by the association of men from other departments of Astronomy, and even other branches of science. […]

« Ce qui me préoccupe surtout c'est de voir la tendance qui se manifeste dans la Conférence à vouloir toujours augmenter un travail déjà si considérable en lui-même » (Procès-verb., p. 51). We would respectfully associate ourselves with M. Cornu in his anxiety.

(*The Observatory,* 1891, pp. 184-5)

RESOLUTIONS OF THE PERMANENT INTERNATIONAL COMMISSION:

1891:

- Priority for the Chart clichés
- Priority for the set of even number declinations, single exposure
- Set of odd number declinations, double or triple exposure
- Adoption of a reducing metal screen
- Final distribution of the work

➔ **beginning: SUMMER 1891**

Distribution of the photographic work (1891)

+90°	+65°	Greenwich
+64°	+55°	Vatican
+54°	+47°	Catania
+46°	+40°	Helsingfors (= Helsinki)
+39°	+32°	Potsdam
+31°	+25°	Oxford
+24°	+18°	Paris
+17°	+11°	Bordeaux
+10°	+05°	Toulouse
+04°	-02°	Algiers
-03°	-09°	San Fernando
-10°	-16°	Tacubaya (= Messico City)
-17°	-23°	Santiago
-24°	-32°	La Plata
-33°	-40°	Rio de Janeiro
-41°	-51°	Cape of Good Hope
-52°	-64°	Sydney
-65°	-90°	Melbourne


PARTICIPANT OBSERVATORIES
Helsinki
Potsdam
Oxford
Greenwich
Paris
Bordeaux
Toulouse
Vatican
San Fernando
Algiers
Catania

PARTICIPANT OBSERVATORIES

RESOLUTIONS OF THE PERMANENT INTERNATIONAL COMMISSION:

1896:

The first 7 resolutions concern the Catalogue

- Set of Chart clichés, odd declination, triple exposure
- Photoengraving of Chart clichés on copper plates

RESOLUTIONS OF THE PERMANENT INTERNATIONAL COMMISSION:

1900:

- Santiago → Montevideo (provisory)
- La Plata → Cordoba
- Rio de Janeiro → Perth (provisory)
- Alternative for odd declinations clichés (single exposure, 40’ or triple exposure, 30’)
- Sub-commission for Eros observations (1901)

RESOLUTIONS OF THE PERMANENT INTERNATIONAL COMMISSION:

1909:

- Australian observatoires are solicited to publish their sections of the Catalogue
- Santiago → Hyderabad
- Cordoba → Cape of Good Hope

?!

- Other plates to measure proper motions
- Special set of clichés for the 'Selected Areas' (Kapteyn)
- Triple exposure clichés to be taken in different nights

- Instruments adjustments

RESOLUTIONS OF THE PERMANENT INTERNATIONAL COMMISSION:

1909:

Establishment of 3 sub-commissions:

- Reference star catalogue
- Eros Parallax
- Special Studies

➔ **The project fragments!**

Distribution of the photographic work (1891)

+90°	+65°	Greenwich
+64°	+55°	Vatican
+54°	+47°	Catania
+46°	+40°	Helsingfors (= Helsinki)
+39°	+32°	Potsdam (later replaced by Uccle)
+31°	+25°	Oxford
+24°	+18°	Paris
+17°	+11°	Bordeaux
+10°	+05°	Toulouse
+04°	-02°	Algiers
-03°	-09°	San Fernando
-10°	-16°	Tacubaya (= Mexico City)
-17°	-23°	Santiago (later replaced by Hyderabad)
-24°	-32°	La Plata (later replaced by Cordoba)
-33°	-40°	Rio de Janeiro (later replaced by Perth)
-41°	-51°	Cape of Good Hope
-52°	-64°	Sydney
-65°	-90°	Melbourne (later replaced by Sydney)

EUROPE

AMERICA

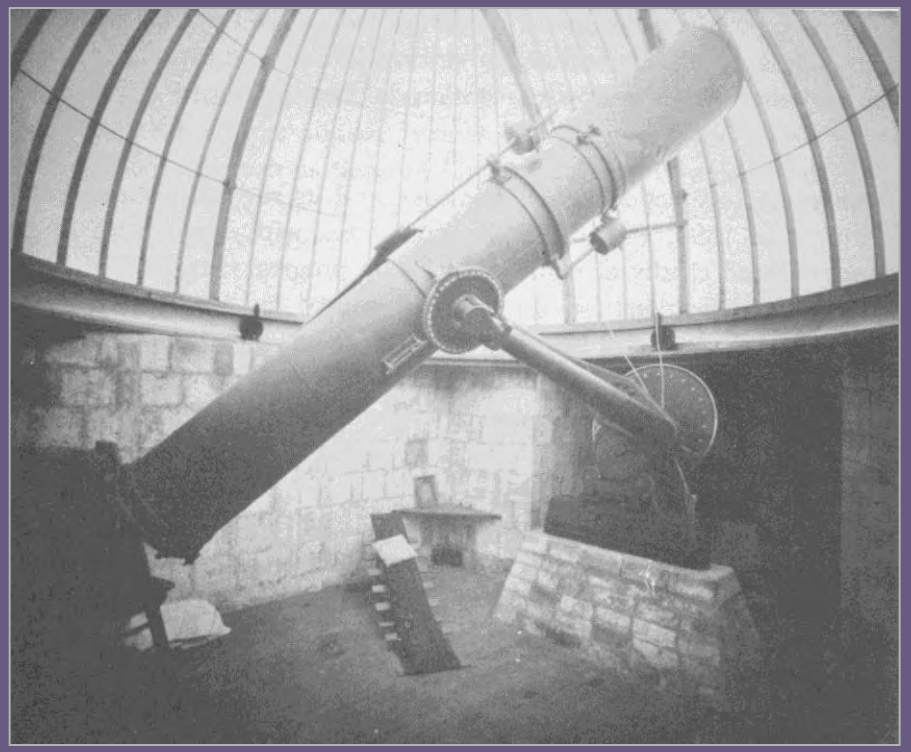
AFRICA

ASIA

OCEANIA

PICKERING PROJECT

- Cost of the instrument : 250,000 FF (£. 10,000, $ 50,000)
- Aperture : 24-inch. (double) ; focal lenght : 11-feet
- Field : 5°x 5°
- 2, 000 plates
- Estimated duration : 2-3 years



BRUCE TELESCOPE
(Arequipa, 1895)

Your letter to the Congress received much more consideration than you appear to think. […] The question of the adoption of combinations giving very large fields, composed of 4 lenses was fully talked out …

The scale of magnitude and accuracy to be attained were really the points which went against the 4 glass combination. Nothing less that 14th magnitude stars would satisfy a large number of members of the Congress and it was felt that if we go beyond 15 minutes of exposure we ran some risk of failure. To combine these conditions would have involved the use of lenses of 12 or 13 inches aperture and 4 glass lenses of this aperture would have cost too much – indeed I do not know if we could get them made at all. […] I hardly think you can use so large a field to advantage because of the changes in the differential refraction during exposure – the correction of a 4 glass objective is also a species of compromise and the law of distortion is probably troublesome to deal with. In fact **the Congress was determined to do the work on a scale of accuracy and magnitude which appeared to exclude the use of double combinations.**

(Gill to Pickering, 1887)

... if Prof. Pickering is right in thinking that he can chart the whole sky in two or three years with a single telescope, then the combination of seventeen observatories to do the same work is all wrong ...

He has thrown out a distinct challenge, and matched himself against the rest of the world in the same undertaking. […]

... he has tacitly condemned the work of the International Conference before it is commenced, and claimed success for itself; whereas it is comparatively certain that the former work will be carried out, based as it is on definite work with a known instrument; while his own plan depends on that assumption, which has so often proved delusive, that a telescope may be multiplied by three.

(*The Observatory*, 1889, pp. 310-11)

Pickering, 1898-1903

Photographic Map of the Sky

Apertura: 1-inch.

Focale: 13-inch.

12ª magnitudine

30° x 30°

Esp.: 1 h

55 lastre

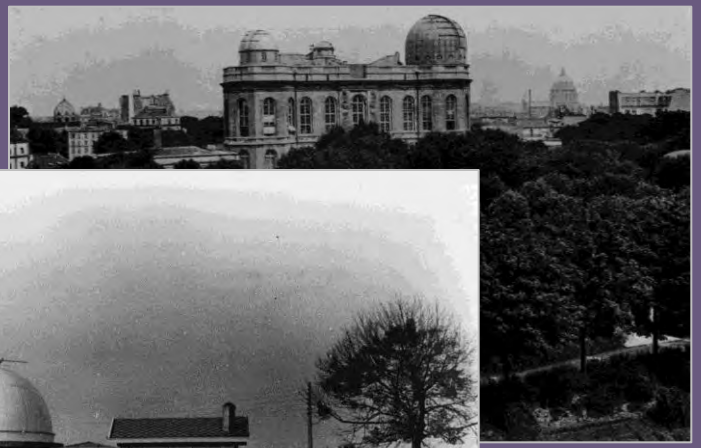
8 x 10 inch.

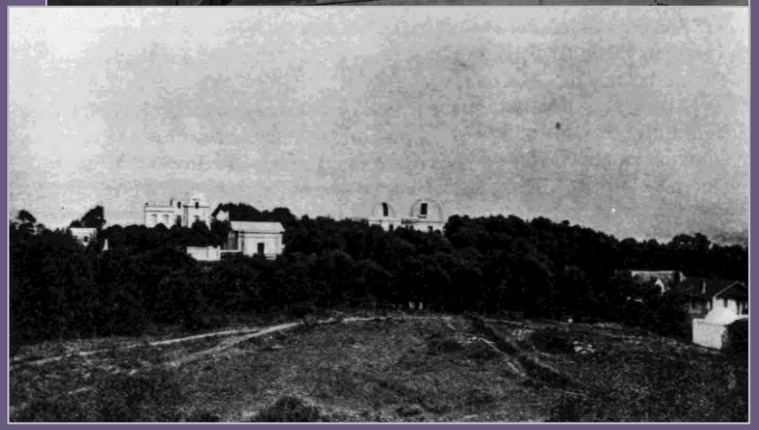
… there is a pretty strong feeling that your chart will be a much better and more practical one that ours – as a chart, and that **our true function is the Catalogue** – indeed there was a motion very nearly carried out that **we should leave the chart aside and push on the Catalogue plates** – And this would have been carried I believe but for the fact that **the French astronomers want money from the Government for "personnel"** to carry on the work, and that **whilst the Chart appeals to the general public – and millions of stars appeal to the popular imagination, the solid work of a catalogue does not do so.** Thus a compromise was reached which permitted the Frenchmen **to say that the chart was to be commenced at once, although the catalogue plates were first to be pushed on.**

(Gill to Pickering, 1891)

Distribution of the photographic work (1891)

+90°	+65°	Greenwich
+64°	+55°	Vatican
+54°	+47°	Catania
+46°	+40°	Helsingfors (= Helsinki)
+39°	+32°	Potsdam (later Uccle)
+31°	+25°	Oxford
+24°	+18°	Paris ←
+17°	+11°	Bordeaux ←
+10°	+05°	Toulouse ←
+04°	-02°	Algiers ←
-03°	-09°	San Fernando
-10°	-16°	Tacubaya (= Mexico City)
-17°	-23°	Santiago (later Hyderabad)
-24°	-32°	La Plata (later Cordoba)
-33°	-40°	Rio de Janeiro (later Perth)
-41°	-51°	Cape of Good Hope
-52°	-64°	Sydney
-65°	-90°	Melbourne (later Sydney)





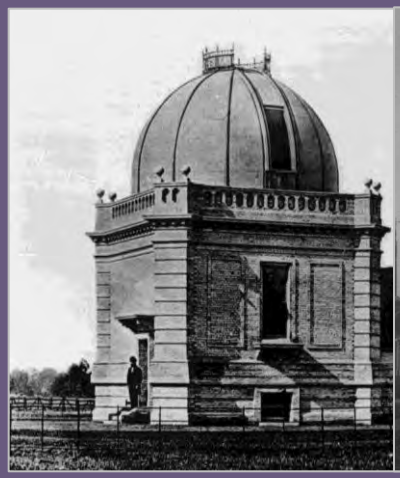
FRENCH OBSERVATORIES

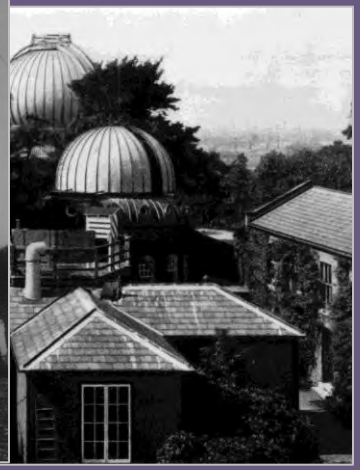
- Total number of plates : 5,000
- Total amount of Chart costs : 1,000,000 FF
- Total cost for printing 12 volumes x 4 Observatories : 500,000 FF

BRITISH OBSERVATORIES

- Price of Grubb Astrograph: £. 1,500 (37,500 FF)
- Catalogue : 2,000,000 stars, estimated duration : 25 years
- Estimated cost : 250,000 FF (£. 10,000) per year

(£. 1 = 25 FF)





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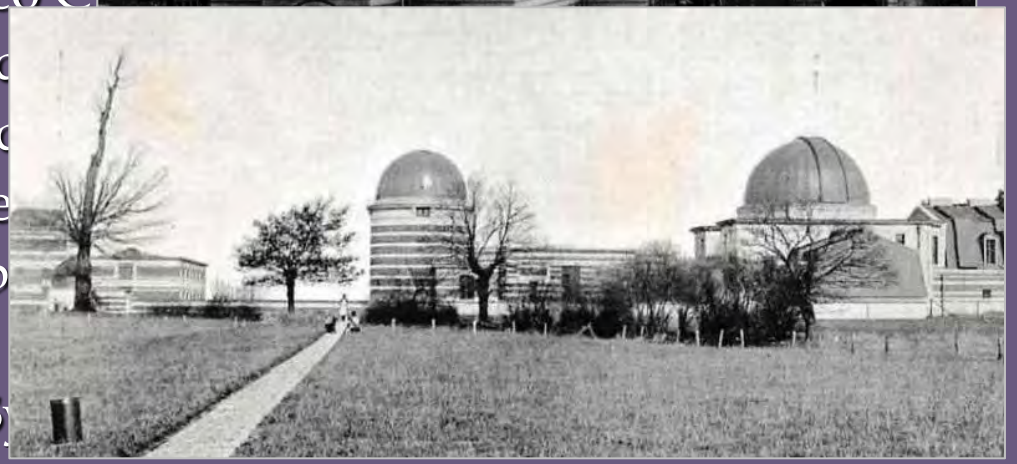
-52°	-64°	Sydney
-65°	-90°	Melbourne (later S



Distribution of the photographic work (1891)

+90°	+65°	Greenwich
+64°	+55°	Vatican
+54°	+47°	Catania
+46°	+40°	Helsingfors (= Helsinki) ←
+39°	+32°	Potsdam
+31°	+25°	Oxford
+24°	+18°	Paris
+17°	+11°	Bordeaux
+10°	+05°	Toulouse
+04°	-02°	Algiers
-03°	-09°	San Fernando ←
-10°	-16°	Tacubaya (= Mexico City)
-17°	-23°	Santiago (later Hyderabad)
-24°	-32°	La Plata (later Cordoba)
-33°	-40°	Rio de Janeiro (later Perth)
-41°	-51°	Cape of Good Hope
-52°	-64°	Sydney
-65°	-90°	Melbourne (later Sydney)

The importance of this matter can scarcely be over-estimated.

It is a direct invitation from the entire scientific world to participate in the greatest scientific work that has ever been undertaken in the world's history …

… we have the opportunity of acquiring scientific lustre.

(Cooke to Colonial Secretary, 1896)

ASTROGRAPH of PERTH OBSERVATORY (1901)

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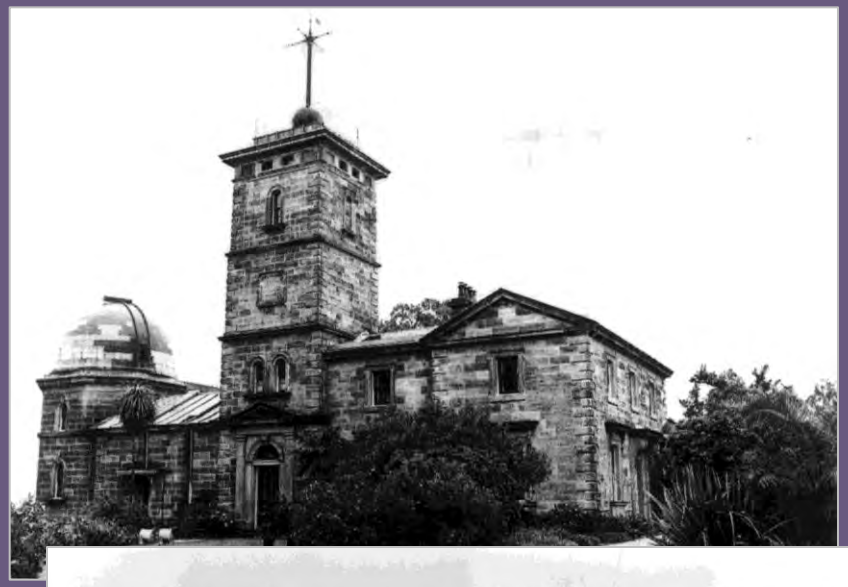

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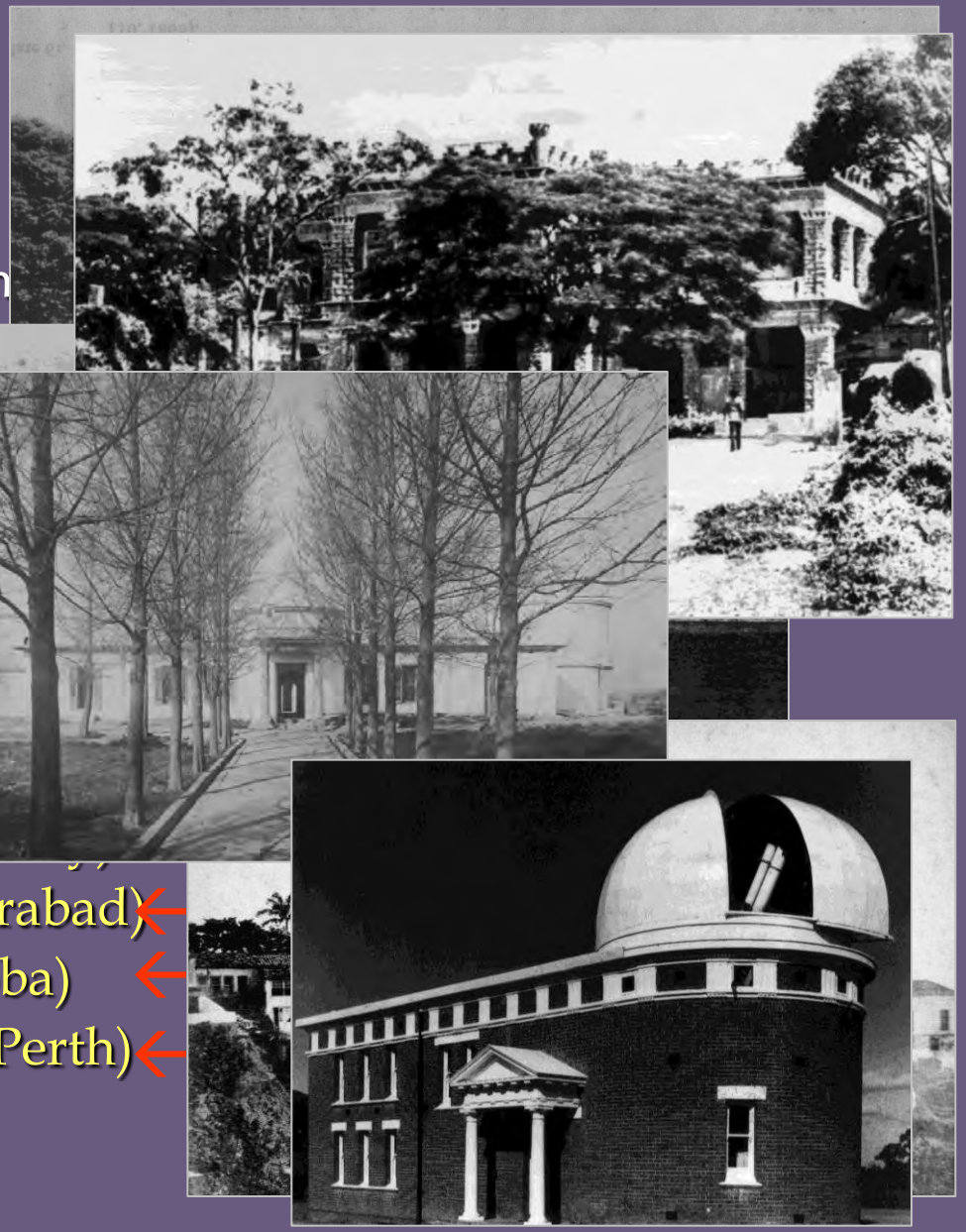

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Sir Howard GRUBB (1844-1931)

I shall be glad to hear from you as soon as possible about the details of the photographic telescopes. **Are there not one or two of them to be made for Australia as well as for Greenwich and the Cape?** Of course, the greater number I have to make, the less price I can make them for.

(Grubb a Gill, 1887)

Now I don't think there can be any reasonable doubt that these instruments can be made in our own Country at last as well, probably decidedly better, than in France and my estimate is lower than that of the Frenchmen. **If therefore the Government send their orders to France** they will have to be prepared with a good reason to do so as **I shall certainly take steps to have the question raised in the House.** I cannot however think it likely that the Government would go off hand and order instruments […] without waiting for the advice of the two societies most interested; however this matter has put me upon my guard and I think I had better be on the spot whenever any discussion comes on.

(Grubb a Gill, 1887)

There is no prospect of the completion of any 13-inch. Photo-objective in England for some time to come. I have already examined three objectives as supplied by Sir Howard Grubb, but **neither of them has proved efficient for the purposes of the "Carte du Ciel".**

(Pritchard to Mouchez, 1889)

Grubb has been induced to attempt the impossible, to cover a field larger than 2° x 2° with sharp images. This cannot be done (at least with an object glass of 2 lenses), and it is no wonder that he has failed.

(Gill to Mouchez, 1889)

I am not in the least disquieted by the civil war in Chili nor by the other troubles which you describe in Buenos Ayres. We shall get from these places precisely what I expected, viz. nothing at all.

But why disquiet yourself? […] It will not be a very serious matter if we have to undertake all the Southern Hemisphere […] – I mean the mere photography. **The measurement of the plates** is another matter – and I feel convinced it **can be best and most economically done in a Central Bureau.** Of course if we can get the money there is no reason why we should not make the measures here, but **women's work** for this purpose can be procured in Europe at so much less cost than here, and could be so effectually organized and so economically supervised in a single establishment, that I am convinced we shall all be ultimately compelled to adopt that method of working.

(Gill to Mouchez, 1891)

BUREAU DES MESURES (1891)

Dorothea KLUMPKE (1861-1942)

COSTS (on average) per Observatory

Instruments : 40,000 FF (1899)

Photographs and measurements : 250,000 FF (12 plates = 7 FF, 1893)

Publications : 500,000 FF

(staff average cost = 15,000 FF, 1898 ;

Publications, materials and measurements annual costs = 21,000 FF, 1899)

TOTAL COST :

Photographs and measurements : 6,000,000 FF

Publications (Chart and Catalogue): 12,000,000 FF

Average annual salary of an astronomer : 300 FF (1893)

Cost of a measured plate : 200 FF

MEETINGS OF THE INTERNATIONAL PERMANENT COMMISSION :

- 1889
- 1891
- 1896
- 1900
- 1909

1814-1818 – First World War

- 1919 Establishment of IAU
- 1922 First IAU General Assembly (Rome)

➔ **Commission 23**

ACTIONS OF IAU :

CARTE DU CIEL

- 1964: completion of the Catalogue
  (publication of the last 20 volumes)

- 1970: interruption of the work for the Chart (Brighton GA); C23 (*Carte du Ciel*) + C24 (Parallaxes & proper motions) → C24 Photographic Astrometry

- 2000: C24 + C8 (Positional Astronomy)
  → C8 Astrometry (WG *Carte du Ciel*)

Sky zone	assigned to	carried out by	Sky charts
+90° to +65°	Greenwich		All charts printed
+64° to +55°	Vatican		Heliogravures for 1/3 of +55°, +56°, +57°; the remaining printed on photographic paper
+54° to +47°	Catania		**NONE**
+46° to +40°	Helsingfors		**NONE**
+39° to +32°	Potsdam	Uccle	Heliogravures for the entire zone printed and distributed by Uccle
+31° to +25°	Oxford		**NONE**
+24° to +18°	Paris		Heliogravures for the even zones +18°, +20°, + 22°, +24°
+17° to +11°	Bordeaux		Heliogravures for the even zones +12°, +14°, +16°
+11° to +05°	Toulouse		Heliogravures for the odd zones +5°, +7°, +9°
+04° to -02°	Algiers		Heliogravures for the odd zones -1°,+1 °,+3°
-03° to -09°	San Fernando		Heliogravures for the odd zones -5°, -7 °,-9°
-10° to -16°	Tacubaya		Heliogravures for the zones -11°, -13 °, -15°, -16 °
-17° to -23°	Santiago	Hyderabad	**NONE**
-24° to -32°	La Plata	Cordoba	Heliogravures for the zone -25° only
-33° to -40°	Rio de Janeiro	Perth	**NONE**
-41° to -51°	Cape of Good Hope		**NONE**
-52° to -64°	Sydney		**NONE**
-65° to -90°	Melbourne		**NONE**

WEAK POINTS OF THE PROJECT :

- Ambiguity and diversity of purposes (Chart and Catalogue)
- Choice of the instruments (not homogeneous)
- Management failures and open questions
- Different political and economic situations of the partecipant Countries

UNEXPECTED DIVERGING FACTORS :

- Political instability of the governments
- World conflicts
- Development of new technologies (Schmidt cameras)
- New scientific frontiers (extra-galactic astronomy)

FINAL REPORT:

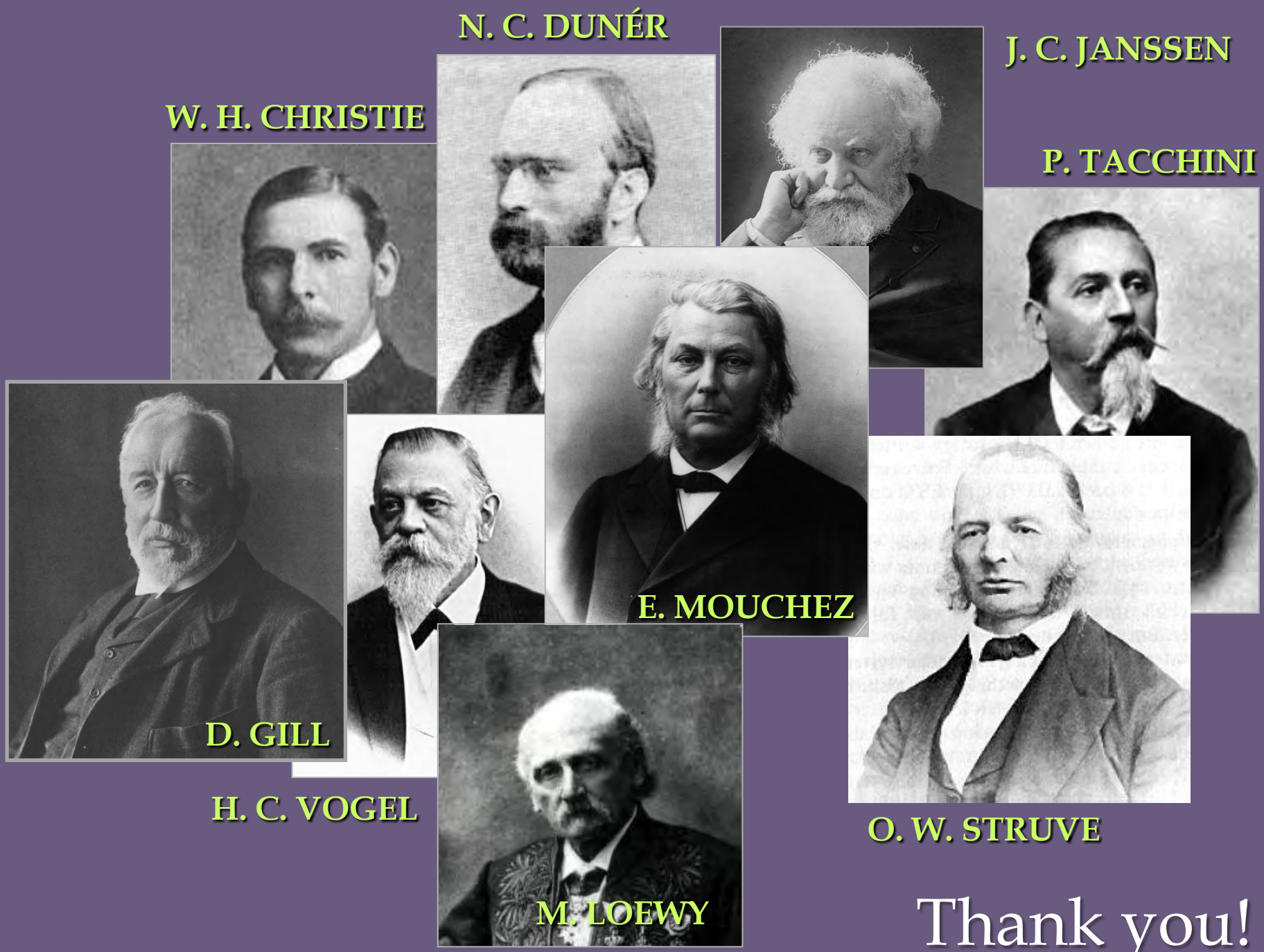
- 22 participant Observatories
- Time employed : 20-40 years per person
- 150 volumes published
- 4,600,000 star positions measured
- 8,600,000 coordinates *x, y* measured

RECENT ISSUES:

AC 2000, ACRS and ACT (Urban et al. 1997)

The Carte du Ciel enterprise has established the foundations of the international scientific cooperation, has introduced the application of photography, showing its difficulties, its methods, its limits. Those who have generously cooperated to it, deserve our gratitude, and the results that the Catalogue is expected to provide in a near future, will certainly justify their perseverance.

(P. Couderc, Brighton IAU GA, 1970)


N. C. DUNÉR
J. C. JANSSEN
W. H. CHRISTIE
P. TACCHINI
E. MOUCHEZ
D. GILL
H. C. VOGEL
O. W. STRUVE
M. LOEWY

Thank you!

Thank you!