

THE INVENTION(S) OF THE TELESCOPE [THE TELESCOPE INVENTED IN CATALONIA?] THE STUDIES OF DR. JOSEP MARIA SIMON DE GUILLEUMA

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Summary: The last few years have brought major additions to our knowledge of the details and circumstances surrounding the inventions (I stress the plural) of the telescope in the late 16th and early 17th centuries in Western Europe. Those telescopes required the prior development of both concave and convex lenses for eyeglasses, ulleres, and we now have a much clearer picture of the sequence of their development and the centers in which they were fashioned. In particular we also now have a much more detailed account of the evolution of the technical means, the operational details, which eventually lead to the creation of the relatively high quality lenses which in turn made possible the invention of the first astronomical quality instruments. And finally we begin to have knowledge, largely invisible until the fall of 2008, of centers for lens crafting in Catalonia. What follows is a preliminary and tentative exploration of the substance and implications of this new knowledge, what has been accomplished and what yet needs to be done, with regards to the lens and eyeglass crafts in Girona and Barcelona towards the end of the 16th century. We also now have the opportunity of investigating the development of those crafts in the Catalan regions from about the turn of the millennium and of comparing the said evolution

¹ My sincere thanks to colleagues and friends who materially contributed to this project: Nick Pelling brought the works of Dr. J. M.a Simon de Guilleuma to my attention and was very open with the results of his own research; Victor Navarro Brotons has helped and encouraged me over these many months; the descendents and family of Dr. Simon de Guilleuma have provided much of the core documentation; and both Angela Saviori and Romualdas Sviedrys helped with key translations.

with that of other centers in Europe. Out of this should come a clearer picture of what had to be in place in the pertinent crafts before a telescope could be invented. Obviously this is a tall order; but then I only intend this paper as a summary and perhaps a call to action.

In 1959 Dr. Josep Maria Simon de Guilleuma (1886-1965), a prominent ophthalmologist of Barcelona with a strong interest in the history of his profession, gave two presentations regarding important results of some of his own researches. One was relatively informal, a public broadcast over Radio Barcelona²; the other was a more formal paper which he gave at the 9th International Congress of the History of Science held that year in Barcelona-Madrid³. Both were based on the same information, data which he had recovered from published and archival sources, and which had led him to conclude that one Joan Roget, a lens and eyeglass craftsman of Girona, had constructed, "invented", the telescope. This would have been in the early 1590s, more than a decade before the normally accepted date for the invention of the instrument, in 1608 in the Low Countries, by one Johann Lipperhey of Middleburg and obviously before Galileo's first telescopes of 1609. Moreover, Simon Guilleuma had found evidence concerning an older brother by the name Pedro who had an optician's shop in Barcelona; Pedro and two of his sons, who were known to do excellent work, constructed several of these instruments in the same years. Here I should say that I have no doubt that Simon Guilleuma's basic conclusions were substantially correct. This was pioneering scholarship. However, as with other examples of such scholarship, the results raise as many questions as they answer, one of the latter being: "What did Simon Guilleuma have in mind when he used the word *telescope*?". Unfortunately, in the years following 1959, as far as I know, no one continued or extended his research, either in Catalonia or elsewhere.

My guess is, in fact, that few people outside Catalonia were even aware of these results. While it might be expected that the Radio Barcelona presentation would have been little known outside Barcelona itself, the paper delivered to the History of Science Congress also went unnoticed. The "Acts" of that Congress were indeed mentioned in the *Isis* "Critical Bibliography", but the individual papers were not cited. Nor was Simon Guilleuma's paper cited in the more specialized literature of those whose interests were in the history of the telescope. In recent years it was even invisible to Vincent Illardi, author of *Renaissance Vision from Spectacles to Telescopes*, 2007, an otherwise massive treatment of the evolution and history of the lens and eyeglass craftsmanship in many centers of Western Europe, an evolution which created the very possibility for the making of telescopes. This was particularly unfortunate because, given Illardi's coverage, one might have thought that neither Catalonia nor Castile

² Simon Guilleuma, J. Ma, 1959, *Juan Roget, óptico gerundense, inventor del telescopio y Los Roget de Barcelona, constructores del mismo*, *Notas Bibliográficas*, in *Boletín de divulgación histórica de ciudad de Barcelona (Instituto Municipal de Historia)*, Vol. 10, N^o. 775, 19.X.1959. (Divulgación histórica de Barcelona [Texto impreso]: textos del boletín semanal radiado a través de Radio Barcelona, por el Instituto Municipal de historia de Barcelona / Ayuntamiento de Barcelona) Broadcast Transcript available at the Barcelona Arxiu.

³ Simon Guilleuma, J. Ma, 1960, *Juan Roget, optico español inventor del telescopio*, in *Actes du IXe Congrès international d'histoire des sciences*, Barcelona-Madrid, 1-7 septembre, 1959: 2 Vols., Barcelona, Asociación para la Historia de la Ciencia Española, 1960, pp. 708-712.

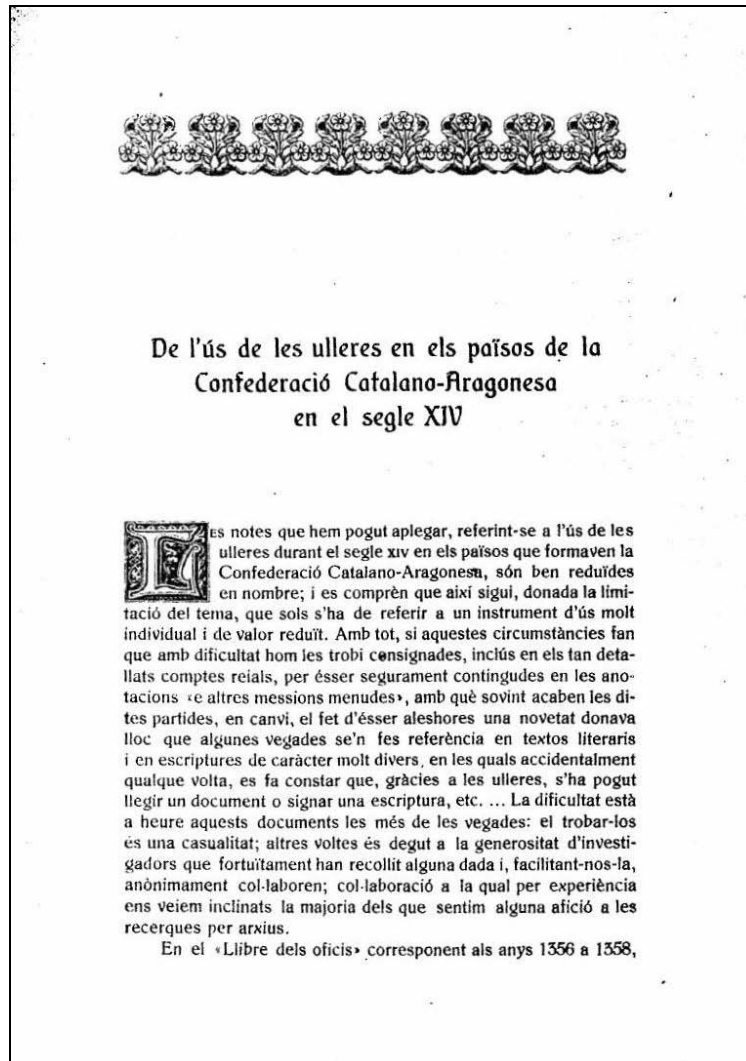


Fig. 1. First page of the *De l'ús de les ulleres en els països de la Confederació Catalano-Aragonesa en el segle XIV*.

had participated significantly in that history.⁴ We shall see, however, that the contrary is the case, as Dr. Simon Guilleuma's many other historical investigations amply demonstrate.

In fact, Dr. Simon Guilleuma had begun historical researches many years before the 1959 presentations. Already in 1923 he gave a paper to the III Congrès d'Hist. de la Corona d'Aragò in Valencia entitled: *De l'ús de les ulleres in els països de la Confederació Catalano-Aragonesa en el segle XIV*⁵(Fig. 1). In the meantime, possibly as early as 1922, he began drafting a series of shorter tracts on the history of lenses and eyeglasses which he hoped to publish in collected form under the title *Notes per a la Historia de les Ulleres*. Over nearly a decade many of these were set to type ready for collective printing, but the project never came to fruition, possibly as a result of the policies of the central Spanish government in the 1930s which suppressed interest in specifically Catalan history and culture.

⁴ Ilardi, Vincent, *Renaissance Vision from Spectacles to Telescopes*, 2007, Philadelphia, American Philosophical Society, pp 148-150.

⁵ Simon de Guilleuma, J. M. 1923, *De l'ús de les ulleres in els països de la Confederació Catalano-Aragonesa en el segle XIV*, València, III Congrès d'Hist. de la Corona d'Aragò, Vol. I (1923), 485-501.

Through the great kindness of Dr. Josep M. Simon i Tor and his colleagues in Barcelona I have been given copies of 16 of them, and I now know that others of his studies were also set to type and that yet others may exist in draft form. I shall come back to the subject below.

Given these long standing interests, it should be no surprise that Simon Guilleuma eventually came across a book which a Milanese gentleman had published in 1618: *Telescopium, siue Ars perficiendi nouum illud Galilaei visorium instrumentum ad sydera ...*. The author, Girolamo Sirtori (m. 1631) was among the first in Milan to hear of, and to have in his hands, one of the new viewing tubes. These had begun arriving in Italy from the Low Countries in 1609, and Sirtori apparently conceived a strong desire to learn how to make them himself. By his own account, he soon realized that there were two major problems to be solved: the quality of the glass to be used and the proper means of grinding and polishing the lenses. Accordingly he went to Venice, but there he found little or nothing more than he had already come to know. It was at this point that he decided to go to Spain where, according to him, rumors had it that excellent examples of the new instrument were to be found. If he traveled by land from Milan, he probably used the road between Perpignan, on the French side of the Pyrenees, and Barcelona. In any case, his first significant stop in the Iberian Peninsula seems to have been Girona⁶. While there, word went about that he carried an example of the new 'far seeing' instrument, and he was approached by a local *architectus* (presumably meaning *craftsman*) who insisted on having a look at it. When he came at last to trust the man, he learned that this architect was a retired spectacle maker and that many years previously he had made a similar instrument. This craftsman also had a book describing the art and allowed Sirtori to copy some of the contents. Sirtori learned later that this man was a brother of one "Roget of Burgundy" who lived near Barcelona. According to Sirtori, this Roget of Burgundy "had introduced and established the art in Spain". [There are problems here to which I shall have to return] And he had had three sons, two of whom continued in the craft and were known for the excellence of their work, while one became a Dominican Friar and "wrote down" the art, possibly referring to the book already mentioned.

Simon Guilleuma's own investigation, initially based on the information provided by Sirtori, soon yielded important clarifying results. He found archival evidence which confirmed the existence of the Roget family, their origins and their names. The Girona Roget was Joan; the Barcelona Roget was Pedro, Joan's older brother. Their father was Ramon Roget of Angouleme in the Charente region of France (not Burgundy!), by profession a carder, presumably a wool carder. Pedro was the first of the two brothers to reach Catalonia, establishing himself in Barcelona. He married a local woman named Catalina Isern; she had the children already mentioned: Miguel who entered the Dominican Order, and the two brothers Joan and Magin who followed in their father's craft. Sometime after Pedro's arrival in Catalonia his younger brother Joan followed him. Joan had married a woman by the name of Juana from Malavilla, a small town near Angouleme, in the Bishopric of Rodez.⁷ She died in 1614; her death was documented in the parochial register of the Cathedral of Girona. The couple had no children. Joan himself may have died sometime between 1617 and 1624, the equivalent registers being missing for that period.

So the Roget family really existed. The two original brothers owned and ran optical shops, Pedro first in Barcelona and then Joan in Girona, and both presumably ground lenses and made eyeglasses. And I would expect that the several archives in Barcelona and Girona might yield yet more information: for instance, birth and death dates for all the members of the family, the dates for the opening of the

⁶ Other readers of Sirtori have read this name to indicate the city of *Coruña* in Galicia/Galizia, Spain. See *Santiago, entre o Pico Sacro as agullas primeiros telescopios*, in *Anosattera*, No.1,350, 12-18 Marzo 2009, 2 pp.

⁷ There is probably another mistake here on the part of Sirtori. The only Bishopric of Rodez I have been able to find is in the Department of Aveyron, a considerable distance to the east of Charente.

optics shops of both Pedro and Joan, perhaps detailed accounts of transactions of the two shops, and records of contracts signed by the two brothers.

And another category of questions comes to mind:

- when and where did Pedro and Joan learn their craft?;
- could they have been apprenticed in an optical shop in Angouleme? [but Pedro seems to have started as a laborer in Barcelona];
- or did they do their apprenticeships in Barcelona itself?;
- if the latter, did Pedro do this first, then set up his own shop and afterwards take Joan as his apprentice?

To complete the immediate picture, and possibly answer these questions, it would be nice to know more of the details of the history of the optical crafts in the two cities. Where in the organization of Barcelona's guilds did the optical crafts fit? Were they a sub-category of the glass workers guild or of some other group? We know from other sources that a guild of glass makers was founded in Barcelona in 1455⁸. On the other hand, we know from the aforementioned Vincent Ilardi that⁹:

So far, only two spectacle makers, *mestres d'ulleres*, have been identified in Barcelona – Jacme Berenguer (active, 1422, 1435), and Pere Del Maig (active, 1436). But there must have been others in Barcelona before these dates because in 1403 the city exported to Alexandria in Egypt and to Beyrouth in Syria fifteen gross of eyeglasses (2,160 pairs), and two small cases with unknown quantities in 1408.

Ilardi also cites a source to the effect that "it was only in 1596, apparently, that the guild of spectacle makers was organized in Barcelona". If this is so, we can surmise that until 1596 spectacle makers either belonged to some other guild or operated outside the guild system. Did the Roget brothers, perhaps especially Pedro, take any part in the creation of the new guild? At the time of its creation how many other spectacle maker shops existed in the city; how many masters, apprentices and so on were registered? What is evident at this point is that neither Pedro nor Joan Roget introduced spectacle making into Spain. The craft had long been established, probably for at least 200 years. And it also means that in the late 16th century, both in Barcelona and in Girona, there were ample supplies of polished lenses of all types and thus the setting and circumstances existed in which someone might put two of them together and 'invent' a 'far seeing tube'.

Other questions also come to mind, such as:

- who were the early Catalan eyeglass makers? Were they Christian, Jewish or Muslim?
- if Muslim, what was the effect on the craft of the Mudejar persecutions of 1391-1414?
- what was the market for eyeglasses in Catalonia: only for the luxury trade (Court and wealthy circles) or also for the learned world of the scriptoria in cathedrals and monasteries or even the learned centers of Castile? Does Ripoll enter the picture?
- was there a larger market for eyeglasses in the Mediterranean world of the Crown of Aragon Consortium?

⁸ Williams, Leonard, *The arts and crafts of older Spain*, 2 Vols, 1907: Vol. 2, pp. 232 & 235, from Ilardi.

⁹ Ilardi, p 149. Ilardi suggests that these spectacles could have been imported and then re-exported.

Answers to these, of course, would require larger scale investigations.

But, as I have already suggested, there is at least one other question, a fundamental one in my view, which needs examining here: what did Josep M.a Simon Guilleuma have in mind when he used the word *telescope*? Or more precisely, what was it that Joan Roget invented? It turns out that the answer has more complications than students of the subject have imagined until very recently. In 2008 Rolf Willach, an optical engineer and independent scholar based in Switzerland, published a study entitled: "The Long Route to the Invention of the Telescope"¹⁰. Over many years Willach had searched archives, museums and private collections all over Western Europe (except, unfortunately, Spain) for all types of polished reading aids. These included: 1) the early "reading stones", *lapides ad legendum*; 2) the lenses used in certain reliquary cases for the viewing of the relics inside; and 3) lenses for the correction of normal vision deficiencies, myopia and presbyopia. As an optical physicist he could examine them for the composition and quality of their glass, how their pre-polishing blank discs were produced, how those discs were actually ground and polished, and finally their quality as lenses. The result is that now, for the first time, we have a detailed, empirical-operational account of how, over several hundred years, optical craftsmen developed the means of producing lenses good enough to be used in the early "far seeing tubes" [or "tube glasses"]: this by about the middle of the 16th century. Here it would be inappropriate to try to recount his entire story, but we do need to look at a few of the salient points.

Willach began his exposition by clearly defining what he intended by "telescope"¹¹. For him:

"A telescope may be defined as an optical system whose resolution of distant objects is superior to what one would see with the naked eye." He then continued: "In this definition we find no hint of the construction of that instrument: the emphasis falls solely upon the crucial issue of improved resolution. Therefore, an optical device that enlarges distant objects without providing a clearer image of their details is not a telescope, even if its construction is exactly the same."

Obviously this is a severe definition, and many might be inclined to dismiss it. But by staying with it, Willach has found an explanation for the apparent fact that no one had made a "far seeing tube" until the last decades of the 16th century and even why these "far seeing tubes" were not yet astronomical quality telescopes. Among the steps over the centuries were:

- In Antiquity, B.C.E. that is, artisans already could use rotating mechanisms and polishing media to grind and polish high quality rock crystal lenses¹².
- In the Early Middle Ages, in the last centuries before the turn of the millennium, Middle Eastern grinding techniques spread to France, Germany, Switzerland and Italy. (Willach does not mention the Iberian Peninsula, even though it probably ought to have been included.) These were used to make "reading stones", polished pieces of rock crystal or beryl¹³, which could be laid directly on a manuscript one wished to read, essentially what we would call magnifying glasses.

¹⁰ Willach, Rolf, *The Long Route to the Invention of the Telescope*, in *Transactions of the American Philosophical Society*, Vol. 98, Part 5, 2008.

¹¹ Willach, p. 1.

¹² It has been suggested that these early lenses were used as 'burning glasses' to light ritual fires directly from the sun in sacred settings. P. Solani, *Storia del cannocchiale*, in *Atti della Fondazione Giorgio Ronchi*, Anno LI, Novembre-Dicembre, 1996, pp. 805-872: pp. 815-822.

¹³ The apparent source for the German word Brille, eyeglasses.

- In the Later Middle Ages, 12th and 13th centuries, monks working in monastery shops found that a single thin convex lens of rock crystal, placed directly in front of the eye and not on the manuscript itself would allow a far sighted person, a presbyope, to read that manuscript.
- In the Late 13th century Venetian glass workers discovered that by using natron from Egypt, essentially substituting soda ash for potash (pot-assium-ash), either partly or wholly, for the production of glass (as distinct from rock crystal) resulted in a glass with much improved optical qualities. This new glass, which they called *christallum*, was uncolored and relatively free of bubbles^{14, 15}.
- Also in the Late 13th century: probably also in Venice, glass workers began using the new *christallum* to make lenses, initially used singly in a frame with a handle, what we would later call a *lorgnette*.
- Again in the Late 13th century, optical craftsmen developed the technique of making lens blanks by blowing a glass sphere or bubble and "cutting" two to three centimeter discs from it by pressing the end of a cooled copper tube against the surface while it was still hot. Both the outside and inside surfaces of the proto-lens were smooth and almost spherical. To make a plano convex lens, only the inside surface needed to be ground flat; and to make a concave lens only the outside surface needed to be ground flat. Unfortunately, both types of lens normally had a flaw, an astigmatism resulting from the fact that the 'spherical' surfaces were not quite such; the hot bubble of glass tended to slump, creating an asphericity and thereby an astigmatism. But with nearly identical blanks the resulting lenses could be united in pairs in single frames, that is: eyeglasses, *ulleres*.
- By about 1500 lens makers switched from the above bubble technique to that of cutting lens blanks from flat plates. These flat plates, essentially window glass, were created by the glass blower who first blew a cylindrical bottle; he then cut off the ends of the bottle and laid the sides out flat. These lens blanks thus had two flat surfaces. The lens maker then created the desired curved surfaces of the lenses, both positive and negative, by grinding the lens blanks against molded shapes.
- By the middle of the 16th century, then, an experienced craftsman, taking great care, could produce concave and convex lenses which, when mounted in the right way, would allow a user to see an object on the order of three times larger or one-third the distance away. And the evidence is that many optical workers and others did just this¹⁶. What they saw with these "far seeing devices", however, was only an enlarged image, recognizable but probably with even less resolution of the details than that of the naked eye. In other words, not yet a telescope in the sense of initial requirements of this investigation.

¹⁴ See also: Verità, Marco, *Produzione vetraria in Europa al tempo di Galileo*, in Giorgio Strano (a cura di), *Il Telescopio di Galileo, Lo strumento che ha cambiato il mondo*, Firenze, Giunti Editore, 2008-2009, pp.178-185. There is a considerable difference in the details here and those given by Willach. I am not in a position to judge between them. For the present I will follow Willach, but the accounts will have to be reconciled.

¹⁵ Naturally occurring natron is mostly sodium carbonate or more precisely, sodium carbonate decahydrate (Na₂CO₃·10H₂O).

¹⁶ See: Settle, Thomas B., *Danti, Gualterotti, Galileo: their Telescopes*, in *Atti della Fondazione Giorgio Ronchi*, 61/5 (2006): 24-37.

Finally, according to Willach, there is no evidence that the early decades of the next century, the 17th, saw any substantial improvements in the quality of lenses available. The opticians of the Low Countries, Venice, Florence and other European centers in 1608 had lenses of no better quality than those that had been available for the previous thirty or forty years. In other words, until the fall of 1608 they could only construct what would then be a normal "far seeing tube" with low magnification and poor resolution. The question is, then, how was it that Johann Lipperhey was able to create a telescope, a telescope by Willach's criterion, in the fall of that year. The answer is that Lipperhey found that by placing a holed diaphragm, a circular piece of paper with a hole in its middle about one centimeter or centimeter and a half wide, in association with the convex lens of the "far seeing tube", the lack of sufficient resolution of the image was greatly diminished; in plain words, the resolution became greater than that of the naked eye, and the instrument became a *telescope*. The reason for this was in the nature of the available lenses themselves. Willach had found that the best of those standard lenses had a uniform spherical curvature only in a small area around their centers. Away from those centers the curvatures changed non uniformly, generally becoming greater, thus making it impossible for the instrument to have a single, precise focus and a high resolution. By using a holed diaphragm, Lipperhey eliminated the interference from the outer edges of the lenses, allowing the viewer to see an object's details, otherwise essentially blurred.

The rest of this immediate story is well known. Lipperhey's 'secret' became known and rapidly spread, both by letter and face to face, 'live' as it were, by travelers. Then, by the spring of 1609, actual instruments began reaching Italy. We do not know how detailed most of the written or voiced descriptions were or how faithful the actual instruments were, but in the summer of 1609, Galileo, probably already polishing his own objective lenses and using diaphragms, constructed a nine power instrument. He went on polishing consistently better lenses, which allowed him to construct even higher powered telescopes which, in turn, led to his astronomical discoveries. That, naturally, is a separate story.

At this point it is worth noting that early in the 20th century Vasco Ronchi had set the stage for Willach's results: first by developing the "Ronchi Test" for establishing the optical sphericity of lens surfaces (which Willach himself used) and, second, in his own investigations of Galileo's lenses first published in 1923¹⁷. In the latter he drew attention to the imperfections in Galileo's early lenses along with the improvements as Galileo developed his polishing techniques and moved to higher power telescopes. He saw and noted the diaphragms in the existing two examples, but apparently he took them for granted, not realizing that they may have been the key to the 'invention' of the astronomical quality instruments. He did not pursue the question of the history of the optical quality of the glass itself, but he did conclude that the very possibility of an astronomical telescope derived exclusively from many incremental improvements over time in the artisanship within the glass and lens working crafts with no input from theoretical optics¹⁸.

¹⁷ Ronchi, Vasco, *Sopra i cannocchiali di Galileo*, in *L'Universo*, Anno IV (1923), Num. 10, pp. 791-804. This paper has been reprinted several times, most recently in the *Atti della Fondazione Giorgio Ronchi*, Anno 48 (1993), n. 2, pp. 147-160. It has also been published in two different English translations: *On Galileo's Telescopes*, in the *Atti della Fondazione Giorgio Ronchi*, Anno 47 (1992), n. 1, pp. 131-145, and *On Galileo's Telescopes*, in the *Atti della Fondazione Giorgio Ronchi*, Anno 64 (2009), n. 3, pp.437-451.

¹⁸ Ronchi, Vasco, *Galileo e il cannocchiale*, in *Scientia*, Anno 37(1943), 5 pp. In the abstract he wrote: La ricostruzione delle cognizioni scientifiche nel campo dell'ottica all'epoca dell'invenzione del cannocchiale porta a concludere che questa invenzione non fu un parto della teoria, ma il frutto di tentativi fortunati da parte di artigiani occhialai; per di più, quando lo strumento fu messo in circolazione, tutto l'ambiente scientifico gli si dichiarò nettamente e recisamente ostile. L'A. definisce le ragioni di questa ostilità, e dimostra che essa era conseguenza necessaria delle cognizioni ottiche dell'epoca, dell'indirizzo degli studi filosofici, e della condizione tecnicamente misera dei primi strumenti. Da questo esame risulta definita l'azione galileiana, dal punto di vista tecnico e da quello filosofico.

To return to our own story, we have to return to Catalonia and my original questions: what did Dr. Simon Guilleuma have in mind when he used the word *telescope*; and what did Joan Roget actually invent in Girona? -- My own feeling is that Joan Roget did not construct a telescope, that is a telescope in Rolf Willach's restricted sense, a telescope which provided better image resolution than the naked eye. Instead, Joan did what several of his contemporaries were doing in the same period, experimenting with what I have called a "far seeing tube", an approximately three power instrument with poor resolution. My guess is that his lenses were no better in quality than those of lens makers elsewhere. Substantially improved lens polishing, yielding larger objective lenses with larger areas of optically spherical surfaces, would only come later in the 17th century. Moreover, in his account of the visit to Girona, Girolamo Sirtori made no mention of a circular disc of any kind, much less one with a hole in the middle, the final link in the chain of events leading to Lipperhey's creation of an astronomical quality instrument. With regard to Simon Guilleuma, when he wrote the two papers of 1959 he reasonably assumed what every other student of the subject had assumed up to that time: that towards the end of the 16th century the 'inventing' of the telescope only required the putting together of two already existing lenses of suitable dioptric value, a thin, convex objective and a strong concave eyepiece. Until Willach's recent work, and apart from Vasco Ronchi's studies, no one had made the detailed technical analyses of the lenses themselves and the history of how they were produced. Obviously, mine is not a criticism of Simon Guilleuma's work so much as a comment on the state of lens studies both at his time, and until Willach's work.

* * *

In what we have seen thus far, what Simon Guilleuma did was to call (or try to call) attention to the Catalan side of the telescope story. In a real sense, though, in a good part of his earlier work, including the first paper of 1923 and what I will call the "near publications" of the *Notes per le Història de les Ulleres*, he was also calling attention to the Catalan side of the long history of the lens and eyeglass story, implicitly including its possible links with centers in the rest of Europe and elsewhere. I do not know how much Simon Guilleuma knew of Catalan-Mediterranean history, but I have become impressed with the importance of the so-called 'Crown of Aragon Consortium' for the easy exchange of goods (which presumably could include lenses and eyeglasses) and of technical know how, as well as the trained craftsmen themselves. From the 12th through the 15th centuries Aragon 'controlled' commercially Valencia, Catalonia, the Balearic Islands, Corsica, Sardinia, Italy south of Rome, and Sicily and had strong ties to other maritime powers around the Mediterranean. One thinks of the coast of Provence, Genova, Pisa (effectively the 'port city' of Florence) and Venice, for instance. While traveling by sea was not exactly as easy as going by our own autostrade, it was very much better than walking and using a mule to carry one's goods. I have mentioned that Rolf Willach had proposed that a better glass and eye glasses were first made in Venice in the last decades of the 13th century. If that is so, the news and the technical capacities reached Pisa and Florence almost immediately. While it is true that both could have arrived by land, via Bologna and over the Apennines, they also could have come by sea and in the same way spread along the Occitan coast, past the County of Roussillon and on to Barcelona and Valencia. Speculation, obviously, but legitimate speculation in my view: one incident in Simon Guilleuma's life suggests that he may also have had such a suspicion. Rafael Menacho reported recently that Simon Guilleuma took the opportunity of a trip to Florence to investigate a story that the inventor of spectacles was buried in the Church of Santa Maria Maggiore of that city. He had heard that in it there was supposed to be a tomb with the following inscription¹⁹:

¹⁹ Menacho, Rafael, *Història del les Ulleres*, in *Gimbernat. Revista catalana d'història de la medicina i de la ciència*, 40 (2003), 41-44: p 42.

"Aqui reposa Salvino Armati dels Armati de Florensa, inventor de les ulleres. Deu perdoni els seus pecats. 1317".

When he arrived at the church and asked if he could see the tomb and whatever documents might pertain to it, he was told that there was no such tomb and never had been. (We do not know when Simon Guilleuma made this trip; it could have been in the 1930s or in the years after the Second World War.) What Simon Guilleuma did not know on that occasion was that the story of the Florentine invention of eyeglasses by one Salvino degli Armati was a complete fabrication, a falsification, which had been exposed in 1920 by Isidoro Del Lungo in an article entitled *Le vicende d'un impostura erudita*, in the *Archivio storico italiano*.²⁰ Given the difficult times, the said journal may not have reached Barcelona. What the story tells us, however, is that Simon Guilleuma was a dedicated pursuer of the history of lenses and eyeglasses, wherever any hints might lead him to suspect the existence of useful information. Many other examples of this exist in what I have come to call his "near publications".

These "near publications" are a group of essays, which I have already mentioned, many of which were drafted and set into print, beginning possibly as early as 1922 and ending in 1930, with the intention of publishing them as a collection under the title *Notes per a la Història de les Ulleres*. [See the list of these *Notes* in the *Essential Bibliography* which follows.] They consist of the 16 pre-publication proof copies without, continuous pagination, which I received from Barcelona. For each I have given both the gathering letter and the number of pages in the given gathering. In addition I have included in single {}s the gathering letters and titles of proof copies which presumably once existed; and I have included in double {}s two titles for which there is no gathering letter. All of these I took from cross referencing in the 16 items I do have.

Although conventionally we give the beginning of these *Notes* as 1922, in fact, apart from the date of the printing of the *IV* gathering, December, 1930, we do not have specific dates for the others. It is reasonable to suppose, however, that they fall, more or less between the *De l'ús de les Ulleres ...* of 1923²¹, and the already indicated 1930, in other words before the 1933 paper *Una notícia històrico-medical*. It seems to me that there are several things to mark. First of all, there are two *I* gatherings: a typesetter's error? Then there were a minimum of 16 gatherings and possibly as many as 20 or 22. And then there the gaps in the list; at this point we do not know if there were essays drafted for them but not set to print or if the respective gatherings are simply missing in the Simon Guilleuma papers. The *IA* might well have been left open with the intention of writing an introduction on the eve of issuing the whole volume. One other thing to note is that although at least 16 were set to print not all of them were ready for print. A number of them, for instance, lack all or some of the intended illustrations, even though suitable spaces had been left open in the texts. These observations, plus the fact that the volume as a whole is not listed in any general bibliographical or library catalogue that I could find, have led me to conclude that the composite whole was never issued: hence my label "near publications". With what little I know, I would guess that the final publication was blocked because of its essentially Catalan focus, but obviously that suggestion would need checking.

If we look at the titles themselves, what we find is a list of short essays which might well be thought of as extended footnotes for an eventual book-length *History of Lenses and Spectacles*. On the basis of the complex cross citing of the essays it would be wrong to assume that the alphabetical order of the gatherings reflects the sequence of the composition of the *Notes* (*IB* before *IC* before *ID*, etc.)

²⁰ See: Ilardi, pp 13-18. Isidoro Del Lungo, *Le vicende d'un impostura erudita*, *Archivio storico italiano*, LXXVIII, V, 1 (1920), 48-49.

²¹ Simon de Guilleuma, J. M. 1923, *De l'ús de les ulleres in els països de la Confederació Catalano-Aragonesa en el segle XIV*, València, III Congrès d'Hist. de la Corona d'Aragò, Vol. I (1923), 485-501.

and thereby assume that early on Simon Guilleuma was thinking in terms of a history of the subject mainly in Catalonia, only later widening his horizons to include Northern Italy, the Scandinavian countries, the major glass centers of Germany, and the developments in the Netherlands. However, if we also look at the contents of the essays, we find that right from the beginning he was casting his net rather widely, already looking for clues and sources from around Western Europe and the Mediterranean. Sometime in the process, we do not know when, he “discovered” the Girolamo Sirtori book and subsequently the Roget of Girona. This in turn led to his archival investigations in Barcelona and Girona plus a trip to the archives of Angouleme. A nice story of historical detective work indeed! Where might these researches have led had they not been impeded by troubled times in Spain and Europe at large?

With regard to these observations, it would seem that, although not specifically part of the *Notes ...*, the paper published in 1923, *De l'us de les ulleres ...*, has title to being a full member of the series: see Figure 1.

As for the *Notas ...* themselves, the titles in the following Essential Bibliography will provide an overall sense of the range of Simon Guilleuma's researches. And the three following illustrations will show a bit of the content.

- Fig. 2: Gathering D, *Les ulleres en els scriptoria ...*, a view of a fragment of a sculpture of Sant Joan.
- Fig. 3: Gathering H, *Les ulleres en les marques del paper*, a sample of 15th century water marks for paper, including one from Perpignan in 'Greater Calalonia'.
- Fig. 4: Gathering B, *Les ulleres en els cognomens*, one of many instances of “spectacles” becoming part of family names.

* * *

What becomes evident from this review, I think, is that the invention of the astronomical telescope required a much more complex set of background circumstances than we have imagined until recently. Behind it was a long history which included the discovery of naturally transparent crystals, rock crystal and beryl, for instance, which could be ground and polished for whatever purposes, including the making of lens like objects. Then there was the discovery of the means for making a new, artificial-transparent substance out of ordinary sand, Silicon Dioxide, what we call glass. But because the melting of sand requires a very high temperature there was needed a substance which could be added to the sand to lower that temperature; this initially turned out to be potash, derived from the burning of plant materials. The glass obtained, however, was green and tended to be filled with small bubbles. The next step was the use of natron from Egypt which would serve as well as potash and would produce a clear glass with fewer bubbles. With these developments we arrive in the late 13th century in Venice and Northern Italy, including Tuscany. The still open question is how quickly this practical knowledge diffused to the rest of Europe including, for our purposes, the Iberian Peninsula.

The second major component of the background circumstances was the evolution of the craft techniques for the grinding and polishing of these transparent substances. These originated in Antiquity, and this craft knowledge presumably lasted both in the Eastern Mediterranean and in the West through the so-called Dark Ages. As the West began to revive just before the turn of the millennium, the year

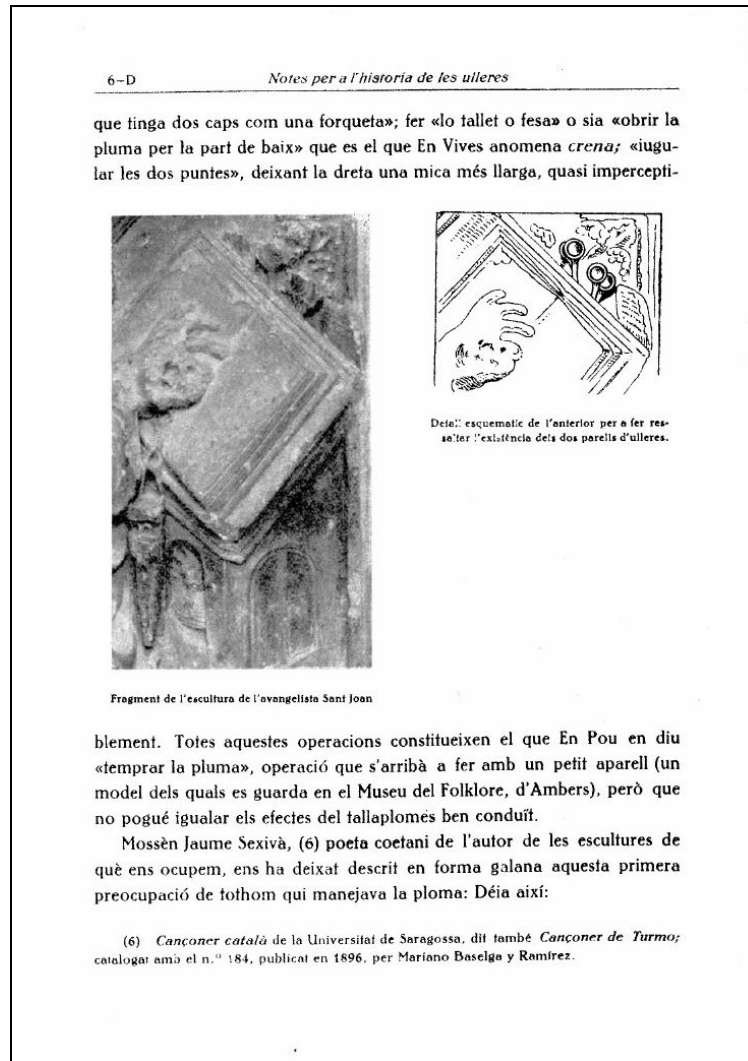


Fig. 2. Gathering D, Les ulleres en els scriptoria ..., a view of a fragment of a sculpture of Sant Joan.

1000, these crafts also revived. For our purposes, the open question is when and under what circumstances did they revive in Catalonia and the rest of the peninsula.

The third strand of these background developments involved the specific techniques required for the creation of lenses. Around 1300 glass workers created ever better means of providing blank glass discs suitable for the making of lenses. These in turn provided the occasion for the growth of a specialized lens making craft. It seems to me that it was no simple coincidence that clear, good quality glass, the relatively simple means of providing blank discs, and improved polishing techniques all arrived at about the same time. Along with the invention of eyeglasses!

Exactly when and how the knowledge and practice of these crafts reached Catalonia is an open question. But it should be obvious from what we have seen of the results of Simon Guilleuma's researches that they had already been implanted in the Iberian Peninsula by the early 14th century.

Finally, I think, there is a fourth required strand leading to the possibility of the creating what I have called the first "far seeing tubes". This was the proliferation of lens and eyeglass making shops plus, of course, the number of craftsmen and artisans associated with them. To my knowledge we do not know what the initial demand for spectacles was in the early 14th century, possibly only for inexpensive types on the part of scholars who required only plain frames plus a few of the rich who

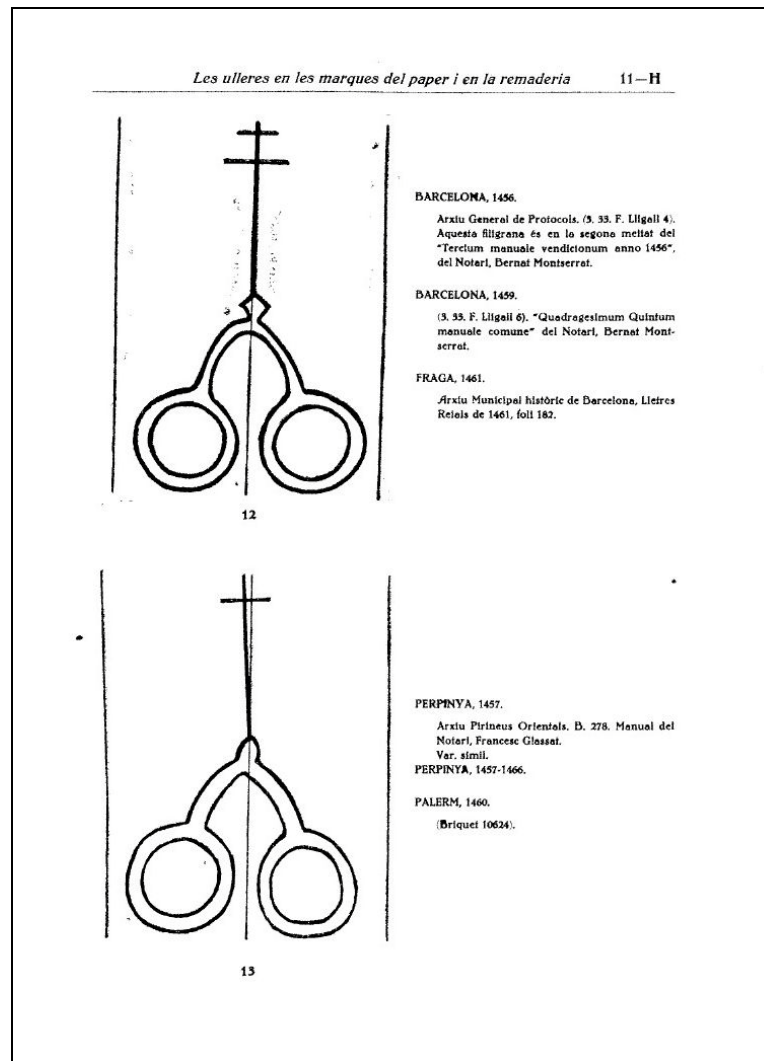


Fig. 3. Gathering H, Les ulleres en les marques del paper, a sample of 15th century water marks for paper, including one from Perpignan in 'Greater Catalonia'.

could afford gold frames. But the market obviously developed quickly; elderly (and therefore) presbyopic bankers, merchants and even shop keepers needed them to manage their account books both of cash and of goods (money and logistic accounts), and an increasing tribe of civil bureaucrats, lawyers and notaries needed them to keep their own records. Optical shops and craftsmen multiplied while polishing techniques improved. Finally about the middle of the 16th century optical shops, craftsmen and lenses had a sufficient density in several European centers for interesting mutations to occur. Craftsmen began putting lenses together and creating "far seeing tubes". This happened in several places in Europe, and it happened in Catalonia, specifically in Girona. What we do not know at this point is whether it happened also in other places in the Iberian Peninsula, in Valencia for instance, or in Castile.

The point here is that behind the evolution towards the telescope was an evolving artisan-technical capacity along with an associated evolution of the economic and social structures which, combined, created the preconditions for the invention.

A few of the questions I have at this point are: 1) How did the said developments from the early 14th century on in Catalonia compare with those in Italy and elsewhere?; 2) Were there similar developments in "Greater Catalonia", including Valencia and elsewhere? 3) Did the expulsions have any effect of the requisite evolutions? Answering questions like these could tell us something about the

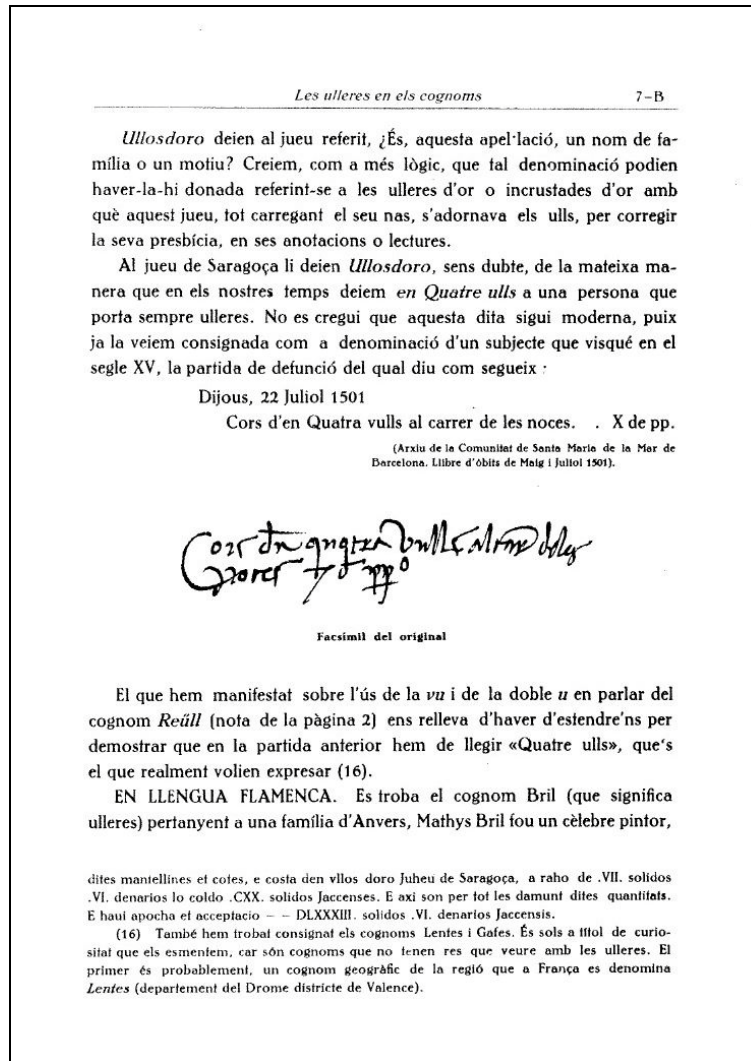


Fig. 4. Gathering B, Les ulleres en els cognoms, one of many instances of “spectacles” becoming part of family names.

nature of the interaction between a society, its culture and its basic technical underpinnings, the interactions over a stretch of time.

Where to start? With regard to Catalonia and the Iberian Peninsula the best place to start would be where Dr. Josep Maria Simon Guilleuma left off. In the papers we have examined briefly, especially these “near publications”, he has left a marvelous body both of particular information and of suggestions of how and where to look for further data.

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[[Note that the proof copies of /E/, /F/, /H/, /I/ lack several planned illustrations. And that still missing from list are gatherings: /A/, /K/, /L/, /N/, /S/; it is possible that /A/ was left open for an introductory essay just prior to publication.]]

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