Journal of Astronomical History and Heritage, 24(3), 776–788 (2021).

INTANGIBLE HERITAGE: CONNECTING ASTRONOMICAL TELESCOPES AND THEIR USERS

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Abstract: The paper explores how, in the recent past, amateur astronomers developed and employed paraphernalia and practices associated with telescopes and the environments they operate in. We approach these issues using three short case studies, focusing on dark adaption, eyepieces and observing journals. The overarching aim is to argue that there is a need for further exploration of the connections between tangible and intangible heritage.

Keywords: amateur astronomy, paraphernalia, dark adaption, eyepieces, observing journals

1 INTRODUCTION

UNESCO's ratification of the Convention for the Preservation of Intangible Cultural Heritage (UNESCO, 2003) has brought intangible cultural heritage into focus for many heritage sectors, generating a wealth of innovative initiatives on both intangible and tangible heritage around the world. The UNESCO Convention explicitly refers to the "... deep interdependence between the intangible cultural heritage and the material cultural and natural heritage ..." In this paper we will use astronomical heritage, in particular in the area of amateur astronomy, to explore how tangible and intangible heritage are interconnected.

Before we continue, something needs to be said about the distinction between amateur and professional astronomers. Generally speaking, the main difference is that whilst professional astronomers have academic training and are paid for their work, amateur astronomers are often, but not always, self-taught and have astronomy as a leisure activity (Kärnfelt, 2015: 162; Williams, 2000: 3–5). This can also be derived from the word 'amateur', which stems from the Latin amator, lover or friend. Thus, an amateur astronomer is engaged in astronomy for the love of it (Stebbins, 1979; 1980a). For more on the definition and nature of amateur astronomers see Orchiston (2015) and Stebbins (1980b; 1981).

Previous research on the history of amateur astronomy has mainly focused on organisational developments (e.g. see Bonifácio, and Malaquias, 2015; Bracher, 1989; Holmberg and Kärnfelt, n.d.; McKim, 1990; Orchiston, 1998; 2017: Chapter 13); on highlighting some of the better-known 'actors' (e.g. Ashbrook, 1984; Chapman, 1998; Dunlop and Gerbaldi, 1988; English, 2018; Orchiston, 2006; 2016; 2017); on the key educational role they have played over time (e.g. see Orchiston, 1991; 1997a); and on amateur-professional relations (e.g., see Hetherington, 1976; Lankford, 1979; 1981; Orchiston, 1999; 2002; Rothenberg, 1981; Stebbins, 1982a; 1982b), including the amateur-turned professional syndrome (Orchiston, 2015).

Where instruments were concerned, the focus has generally been on the design, construction and use of historic and contemporary telescopes (Cameron, 2010; Kärnfelt, 2015; Orchiston, 1997b; 2003; Orchiston and Bembrick, 1995). Some scholars have highlighted the range of practical interactions with astronomical instruments in their multiple settings and surroundings (Schaffer, 1998; Staubermann, 2007). However, there is also increasing demand for studies of the working tools in astronomy, such as flashlights, eyepieces and notebooks (Holmberg, 2012; Staubermann, 2010).

In this paper we aim to shift the attention from actors, organisations and telescopes, toward the interaction between observers and instruments. We are particularly interested in moving away from a telescope-centric perspective in discussions of the history of amateur astronomy's material culture. In fact, a whole range of artefacts and technologies other than telescopes are relevant to understanding the activities of amateur astronomers: domes and other observatory buildings, the sometimes-elaborate chairs and lad-

ders used when observing, special clothes in order to survive long cold nights, star atlases and catalogues, clocks for registering times, etcetera. The amateur astronomer thus needs to operate an assembly of more or less trivial technologies to pursue their observations. We will approach these practices by means of three short case studies, where we will discuss how different tools and techniques have been developed and employed.

2 PARTS, SPARES AND ACCESSORIES: THREE CASE STUDIES

The first case study is written by Kärnfelt and concerns dark adaption and the use of faint red light to preserve it; the second is by Staubermann and discusses the eyepiece, that vital piece of equipment that connects the observer to the telescope; the third is by Holmberg and deals with the use of observing journals to track astronomical activities. These studies, all of which could easily be extended, are intended to illustrate how observers engage with artefacts and the challenges they pose, how observational environments stabilise and what the resulting practices could be. In short, we are interested in how practitioners make instruments 'work' for them. There are other approaches, of course, such as the re-enactment of astronomical practices (Staubermann, 2007) and there is endless potential for more. We hope that this paper will open new historiographic trajectories for exploring and writing about tangible and intangible astronomical heritage and encourage our colleagues to develop them further.

2.1 Working in the Dark

Let us assume that we have bought a 6-inch Dobsonian telescope, a common 'entry-level' instrument, and that we have assembled it and now are trying it out in the comfort of our living room. Handling this telescope is simple, almost intuitive: there are no knobs or levers to keep track of, just use the finder to aim the telescope at a lamppost outside the window, for example, push the tube by hand to the proper position, insert an eyepiece, adjust the focus and start observing.

But let us imagine that we move the telescope outside, into the darkness of our backyard. Suddenly a number of difficulties arise, as weather could affect the telescope in various ways: strong winds can make the mount unstable; humid air might fog up the mirror or the eyepieces; and a sudden weather change can make the sky overcast in minutes. And, importantly, it is dark outside, so it is increasingly difficult to keep track of eyepieces, atlases and notebooks.

The latter factor (i.e. darkness), which we will be our focus here, is more complicated than it seems. Obviously, we could use a flashlight to find our way around the telescope, but this would immediately destroy our dark adaption. Ophthalmologists have known since the 1860s that the retina contains two types of photoreceptor cells, called rods and cones, and, as discovered by Max Schultze (1825–1874), that they serve different purposes (Schultze, 1866). The cones are used under higher light levels (photopic vision), and the rods under lower levels (scotopic vision, or night vision). It also became clear that the rods act differently to the cones: in the dark, a chemical process gradually makes the rods more sensitive, achieving full sensitivity after about half an hour—a process that immediately reverses if they are then subjected to bright light—and importantly, that they are less sensitive to light of longer wavelengths. This is also called the Purkinje Effect, after its discoverer, Czech anatomist Johann Evangelist Purkinje (1787–1869; Jülich, 2002; Miles, 1953). Eventually, this also presented a solution to the problem of exposure to bright light—a source of faint red light will allow you to find your way in the dark without your night vision being affected. The question now is how this issue, and its solution, has been dealt with in the history of amateur astronomy.

Although scientific studies on dark adaption and scotopic vision did not appear until the mid-nineteenth century, astronomers have been aware of and wrestled with the phenomenon since antiquity (Wade, 1998: 171). However, it did not come to the forefront of astronomical practice until the telescopic era (Block and Freeman, 2008).

In the late eighteenth century, siblings Caroline Lucretia (1750–1848) and Frederick William Herschel (1738–1822) launched their two-decade-long hunt for celestial nebulae and, in so doing, opened up a new area of astronomical inquiry (Cunningham, 2018; Hoskins, 2011). Since proper dark adaption is vital for the detection of faint nebulae, they needed to address the problem of night vision. A dim and shrouded candle lantern could do the trick, but William preferred to make observations in total darkness at the eyepiece of their 20-foot telescope, sometimes under a black hood to exclude any stray light. To take notes, Caroline sat at a dimly lit desk below the telescope or indoors at an open window, writing down the information William shouted to her (Holmes, 2008: 118; cf. Herschel, 1800:

54).

In Parsonstown, Ireland, in the 1840s and 1850s, and following in the Herschels' footsteps, William Parsons, the Third Earl of Rosse (1800–1867) specialised in detailed drawings of nebulae (Nasim, 2013), which obviously demanded some lighting. He used dimmed oil lamps to limit the effect on the eye while enabling observers to make their drawings (Block and Freeman, 2008: 72).

Throughout the nineteenth century, this solution is reproduced in different astronomical handbooks.

British optician William Kitchiner (1775–1827) published *Practical Observations on Telescopes, Opera-Glasses and Spectacles* in 1818, where he emphasises the importance of avoiding "… all stimulating and bright objects …" during observations. If light is needed, he recommends using "… a small lantern, which gives a very faint light only on one side, and that may be made dark." (Kitchiner, 1818: 142).

In his *Celestial Object for Common Telescopes*, British clergyman and amateur astronomer, the Reverend Thomas William Webb (1807–1885) mentions the importance of dark adaption in a brief section on observing techniques:

> In examining faint objects, do not prepare the eye for seeing nothing, by dazzling it immediately beforehand with a lamp, or white paper. Give it a little previous rest in the dark, if you wish it to do its best. (Webb, 1859: 15).

Similar advice can be found in other late nineteenth-century handbooks (e.g. Denning, 1891: 65; Proctor, 1873: 28). Judging from these examples, the authors were all well aware of the problem, and they recommended different measures to deal with it.

The first explicit mention of red light in an amateur setting that I (JK) have managed to track down is in the Third Edition of *A Handbook of Descriptive and Practical Astronomy*, which was published in 1877 by the British amateur astronomer George Frederick Chambers (1841–1915). Chambers was in his early twenties when his book was first published, in 1861, and it was to become a great success, and subsequently was published in several significantly extended editions (in 1861, 1867, 1877, 1889/1890, cf. Johnson, 1990). The first edition gives no practical advice, but a lengthy chapter on the subject is added to the second edition, and further expanded in the third edition. This is where red light enters our story:

> The best kind of light for use in an observatory (or out of it) is that which is afforded by a bull's eye lantern, as by means of it you can throw the light on your books or maps without materially distracting the eye. Gas has much to recommend it on the score of cleanliness and saving time and trouble, but the excessive heat which it gives out produces so many currents of air that even with the outmost precautions as to ventilation annoyance will be experienced by the spoiling of the definition. A red shade, consisting either of tinted glass or of red silk tied over the bull's eye of the lantern, is useful when the observer is passing from the examination of a map or book to that of a delicate object; as the eye is less tried by the red than by the white light. (Chambers, 1877: 750).

Bull's-eye lanterns were the forerunners of electric flashlights, and were commonly used by police officers in the nineteenth century (e.g. see Figure 1). They burned oil by means of a wick, and the light was focused by a lens. The brightness of the light beam could be adjusted by opening and closing a slide between the wick and the lens. As we have seen, a variety of lanterns had long been used by amateurs, but the novelty of Chambers' instructions is the introduction of tinted glass and red silk. Where his information came from is unclear, but he was apparently aware that red light is less trying to the eye.

By the end of the nineteenth century, knowledge that red light could be used to avoid disrupting dark adaption was available. Chambers mentions it again in the Fourth Edition of his book (1889/1890), and his remarks were then reproduced by American author Frank Markey Gibson (b. 1857) in *The Amateur Telescopist's Handbook* (Gibson, 1894: 46).

However, the question is how widespread this knowledge really was in amateur circles. In 1957, when British astronomer Patrick Moore (1923–2012) published *The Amateur Astronomer* (Moore, 1957), neither dark adaption nor red lights were mentioned, and although this book went through many editions this topic was always omitted. It also was left out of Moore's edited volume on *Practical Amateur Astronomy* (Moore, 1963). One explanation for this notable omission can be found in the nature of the amateur astronomy that Moore promoted. His main interest, which is apparent from his books, was lunar observations, and since the Moon is so bright, and is dazzling in itself when seen through the eyepiece of a telescope, dark adaption is simply not an issue. During these

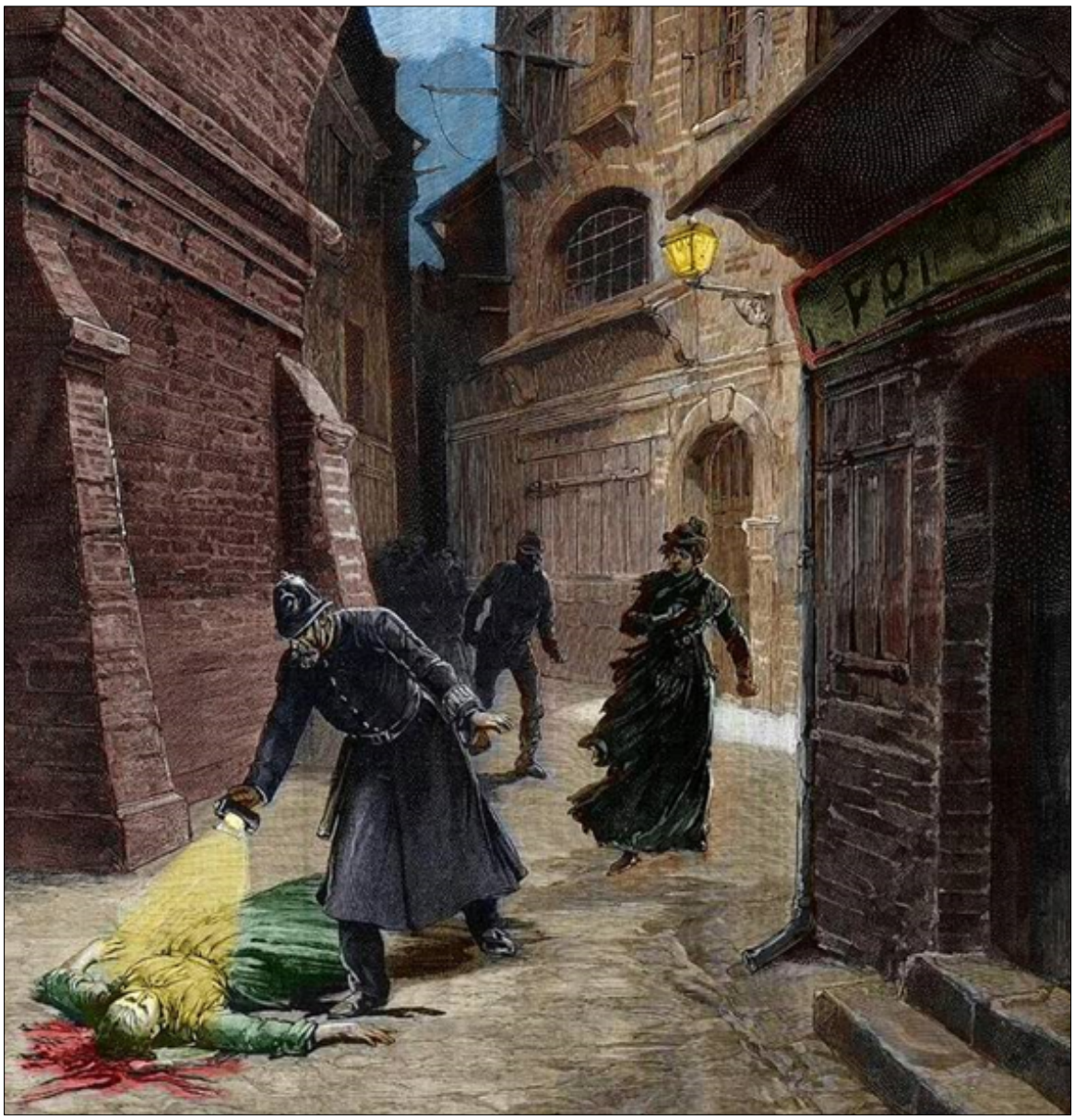


Figure 1: London police officers find one of Jack the Ripper's victims using a bull's-eye lantern. Engraving by Fortuné Méaulle after a drawing of Henri Meyer in *Le Journal Illustré* (Wikimedia commons).

kinds of observations, you can illuminate your surroundings with a flashlight or, if you have the telescope in a permanent observatory, you can use a standard desktop lamp without causing problems.

From the same era, we have John Benson Sidgwick (1916–1958) with his lengthy and highly technical *Amateur Astronomer Handbook* (Sidgwick, 1955). This book, and *Amateur Telescope Making* by Albert Graham Ingalls (1888–1958; 1926), which was first published in 1926, are arguably the two most important (English-language) amateur astronomy handbooks of the twentieth century. In his book, Sidgwick devotes a full chapter to the human eye, and includes an extensive discussion of the importance of dark adaption. And, in a chapter on how to best organise the amateur observatory, suitable light sources are described:

> Working light must be dim, and controllable from the telescope. For a general light about the telescope, a low-wattage bulb may be used; it should be mounted at a sufficient distance to provide a distributed illumination at the telescope equal to about two Full Moons. For the illumination of charts, notebooks, etc, an ordinary torch can be used, the bulb being covered with enough thicknesses of red tissue paper to reduce the intensity to the required level (Sidgwick, 1955: 287).

Illumination corresponding to two Full Moons is actually quite a lot of light, and if turned on



Figure 2: Night view of the upper field at the Texas Star Party 2009 (photograph: Ron Ronhaar and Todd Hargis).

it would definitely ruin the dark adaption needed to observe fainter objects. But, again, this can be explained by Sidgwick's observational interests. He tended to promote observations of bodies within the Solar System, especially planets, such as Mars, Jupiter and Saturn, and they are so bright that dark adaption is not vital. However, for more demanding observations, a flashlight covered with red paper would be more appropriate.

Amateur astronomy was to change in the 1950s (Cameron, 2010; Holmberg and Kärnfelt, n.d.; Kärnfelt, 2017). New production techniques and a developing mass market resulted in amateurs coming into possession of increasingly larger apertures—if a 75 mm (3 inch) reflector was a standard instrument for early twentieth-century amateurs, a 200 mm (8 inch) reflector became the standard for later amateurs. And with greater apertures at their disposal, more distant and very much fainter objects came within reach. Amateur astronomers pushed beyond the confines of the Solar System and 'deep sky observing' and 'deep sky objects' became popular. Promoted by American astronomer Walter Scott Houston (1912–1993), his regular column on "Deep-Sky Wonders" was published in *Sky & Telescope* between 1946 and 1994, and dark adaption became an integrated part of the amateur's on-site preparations and practices (cf. Houston, 1998).

These developments can also be traced in the literature. From the 1970's onwards, dark adaption has become a standard subject in amateur astronomy handbooks (e.g. Cudnik, 2013; Porcellino, 1989; Steinicke and Jakiel, 2007; Thompson and Thompson, 2005), but has also penetrated even further.

Following the spread of deep sky observing, it has been written into the ethics of the amateur astronomy culture, as exemplified by the lighting restrictions formulated by the organisers of the Texas Star Party (see Figure 2), a yearly gathering of deep sky *aficionados*: all vehicle lights must be turned off; only flashlights with red light are permitted; and if, for some reason, you need to emit white light, you have to "… give a yell…" If you do not adhere to these rules, for example by driving your car through the area during observation hours, you "… may be fined $50 or [be] permanently banned from the Texas Star Party …" (Texas Star Party, 2019).

2.2 Connecting the Eye

What is an eyepiece? The main lens of a telescope produces a small image. In order to magnify this image and to see an enlarged picture, but also to overcome any negative side-effects generated by the telescope's main lens, such as chromatic and spherical distortion, a second lens or lens set is needed. This lens is the optical core of the eye-

piece. The eyepiece, which could be regarded as comparable to a microscope, enables observers to magnify the image to suit their specific needs. The questions of how to choose an eyepiece and how to link the observer's eye with the telescope are among the most debated by practising amateur astronomers, but are rarely examined by historians of astronomy.

German amateur astronomer Klaus Soja (Figure 3), a retired IT manager who was interviewed for this paper, will serve as our historic witness here. He can be regarded as a typical amateur astronomer who, like many others, conducts his hobby privately. He kindly agreed to share some of his lifelong experience. Soja grew up in post-War West Germany in the 1950s, when affordable amateur telescopes were rare and those that did exist came with a minimal range of eyepieces, which had simple designs and often tiny lenses. Eyepiece designs were linked to the telescopes, as exchangeability with other telescopes was not taken into consideration. Unlike telescope-making in general, making eyepieces privately was not seen as an option because of the complexity of the optical arrangement (Roth, 1972).

Soja (2018) recalls:

> At the age of 12, I got a Kosmos [a Stuttgart-based company] refractor for Christmas (50/500 cardboard tube with attachable plastic-mounted lens and rack-and-pinion). I also had some accessories. I had neither mount nor tripod, but I was happy and satisfied. At 17 years old, I bought a Newton with a 100-mm mirror, including mount and tripod; the eyepieces were included. I did not need any more, and I did not get any more, as at that time you did not have much money for your hobby. A good 80-mm refractor was practically priceless, but there was no feeling of limitation—a simple pair of binoculars would have been sufficient. There were no choices. If you had opted for a telescope, you had also decided on the manufacturer's accessories (or you bought them too). Compatible accessories from other manufacturers did not exist.

In his twenties, Soja paused his amateur astronomy due to studies and work, but resumed his hobby in the late 1970s. By this time, a new modular system had been invented in Germany, System 64, named after the diameter (in mm) of its various components. This system was invented by the German instrument-maker Dieter Lichtenknecker (1933–1990; Paech, 2018), and enabled the observer to select and combine a previously unknown range of optical equipment in order to customise the rear-end of a telescope, thereby allowing the viewing experience to be adapted to the observer's personal requirements. System 64 (Figure 4) was mechanically superior in its time, as it ensured easy exchangeability for all components, making it widely known in Germany and Western Europe at a time when American or Asian-made equipment was still rare.

Soja (2018) remembers:

> Between 20 and 30 I had to pause practical astronomy due to studies in Bielefeld and five years in Hamburg. The move to Hiltrup brought a change. At the age of 32 [in 1977], I was a high earner and wanted to get the best of the best, so I went for Lichtenknecker. If you bought Lichtenknecker telescopes, you also had to buy System 64, but it only works with

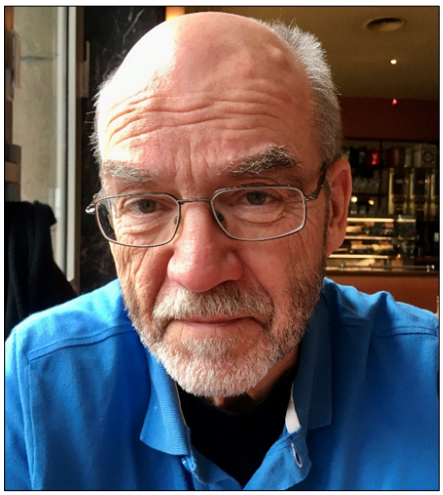


Figure 3: German amateur astronomer Klaus Soja (photograph: Klaus Staubermann).

> 31 mm sockets. The System 64 was exceptionally good. For example, it used temperature compensated material and the parts were mechanically the absolute best, solidly manufactured and correspondingly heavy. There was nothing missing. In those days it was by far the most comprehensive and best accessory programme.

Lichtenknecker equipment was not cheap and Soja could afford it only because he was working full time; typical Lichtenknecker customers included doctors, lawyers, etc. But, as Soja points out, although there was great exchangeability between various Lichtenknecker telescopes, the disadvantage was that the eyepiece diameter was limited to 31 mm (which was slightly different from the later 31.7 mm or 1¼ inch) standard. In the end, this proved too small for larger fields and more immersive optical experiences, with other instrument-makers following suit and developed more exchangeable optical accessories

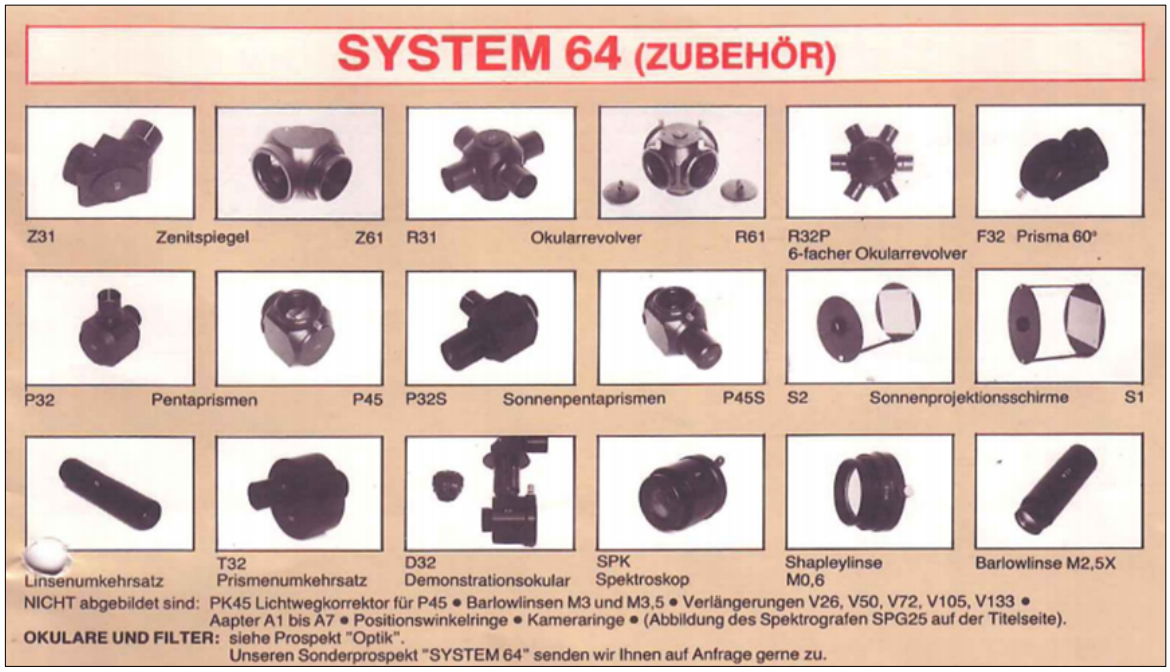


Figure 4: Clipping from the Lichtenknecker Optics prospectus “Spitzenprodukte für die Amateurastronie”, illustrating their System 64, circa 1980 (copyright holder currently untraceable).

that had larger apertures. This led to brighter images and larger fields of view than the previous Huygens, Mittenzwey or Plössl-type eyepieces.

One emerging instrument-maker for optical telescope equipment in the 1980s was Al Nagler in the United States, who founded the TeleVue company (Smith, 2012). By the late twentieth century, international telescope makers were widely known in Germany, due to advertisements in magazines like *Sky & Telescope* and *Astronomy*, and a first generation of import traders.



Figure 5: Newly designed eyepieces were not an instant success, as they often were ‘critical’ designs. For example, the infamous 1980s Nagler 4.8 mm had such a short eye-relief that eyes could water when the observer brought their eye close to the cold eyepiece, or the observer's eyelashes marked the eyepiece lens. This was resolved in a later design, the Nagler 5 mm (photograph: Klaus Staubermann).

Unlike Lichtenknecker, the innovative design of TeleVue telescopes allowed the observer to use 50.8 mm (2 inch) aperture optical components (Figure 5), thereby providing a much more immersive experience, while maintaining the components’ exchangeability.

Companies such as TeleVue, although still targeting the wealthy amateur, offered amateur observers mechanical compatibility with components from different makers and types of telescopes, while also providing a previously unknown viewing experience. However, observers would not willingly part with their precious eyepiece sets. As Soja recalls: “The mating size of the existing 31 mm meant that I switched very late to the extremely good TeleVue eyepieces.”

By the 1990s, companies—mainly located in Asia—had discovered that amateur astronomers were demanding affordable customised equipment (Cameron, 2010: 299). Initially sold as no-name telescopes in department stores, brand names such as Tasco and Vixen became widely known among amateur astronomers (Russian brands remained the exception). In the 1950s and 1960s most amateur astronomers had to make do with the few eyepieces and other optical accessories that came with their telescopes or with trading among themselves.

By the 2000s, these optical paraphernalia had become as important to amateur observers as the telescopes themselves. The varied

range of observational accessories included focusers, diagonals, filters, eyepieces, binoviewers and optical correctors, to name just a few items. For example, a good HII filter would allow visual observation of the faint Horse-head Nebulae. Now the viewing experience could be shaped by the observer, not just the manufacturer. The appearance of astronomy magazines changed correspondingly, with more and more pages dedicated to advertisements and product reviews of telescope paraphernalia (e.g. see Teleskope und Ferngläser, 2017). Last but not least, increased demand led to increased supply and, consequently, decreased equipment prices, making quality eyepieces affordable for the average amateur astronomer in Western Europe and the United States.

Let us try to summarise: until the 1970s, the viewing experience of observers in Western European countries, such as West Germany, was greatly limited by the makers of telescopes and the restricted range of eyepieces they offered. This was followed by a transitional period in the second half of the twentieth century, when telescope-makers increasingly began to provide observers with the means to adapt their telescopes to their personal requirements. Then came a period, from the 1990s onwards, in which an abundance of commercially available optical components enabled observers to almost fully customise their viewing experience to their personal requirements. Once again, it is important to remind ourselves that a telescope cannot be separated from its paraphernalia and auxiliary equipment. Therefore, to understand the practice of amateur astronomy, we must have a good grasp of the material culture of both the telescope and the equipment used with it. Successfully equipping a telescope using customised optical aids and tools provides the observer with meaningful and rewarding astronomical observations.

2.3 Paper Technologies

As an amateur astronomer observes the night sky, an assemblage of various types of paraphernalia is used. Often, there is a telescope involved, with its mounting and accessories, such as a finder scope and eyepieces. Star charts and other information about objects to be observed are at hand, illuminated by a suitable lamp. Arguably, more mundane types of equipment and objects are sometimes of importance for the activities of the amateur under the night sky, such as observing chairs, proper clothing, and perhaps some chocolate or coffee at hand to keep the observer awake and alert.

Amateur astronomy, thus, is an observational activity that involves so much more than just a telescope. Successful amateur observing hinges on getting a group of diverse technologies and artefacts to work together. The topic here is one part of that ensemble: the observing journal, made out of paper and, I (GH) suspect, still in use by many amateurs despite the widespread adoption of laptops, smart phones, and tablets. Paper technologies are stubborn and enduring, and notebooks are centuries-old ways of recording information (Heesen, 2005). In this Section, a number of reflections on the uses of paper journals in amateur astronomy will be made, based on historical sources and my personal experience as an observer.

An amateur astronomer's observing journal is a link in time, an interface between the immediate impressions on the observer's senses and accurate preservation of the observations; if kept in a diligently and in a well-organised manner, these journals represent an ordering of experiences for the amateur astronomer. Committing observational experiences to memory without keeping notes is not to be recommended, and a well-kept journal has been one of the mainstays of observational amateur astronomy. Thomas William Webb (1859), that early teacher of the art of observational amateur astronomy, stressed "… *trust nothing to memory* …", putting the phrase in italics in order to drive home the point, when discussing the usefulness of keeping notes at the eyepiece. At the very least, rough notes should be made under the sky and reduced soon afterwards, lest you forget their meaning, Webb further stated (Webb, 1962: 19). Journals allow an amateur to look back on previous observations; they are a tool for gaining experience as an observer. Thus, journals are an important part of the amateur's progress as an observer and are key to developing the observer's vision, of acquiring a trained eye.

In addition, journals are essential for observations that are made with the intention of recording changes in celestial objects. Observers of variable stars who aim to document their changing brightness over time, the forms of the cloud belts of Jupiter, the brightness and morphology of comets, the number of sunspots, all need to keep journals of their observations, often for further reporting to national or international data-bases. Manuals of amateur astronomy often provide schemes in the form of tables with relevant headings, in order to secure that no vital information is missed. Some authors advise amateurs to keep two types of journals: an observing book

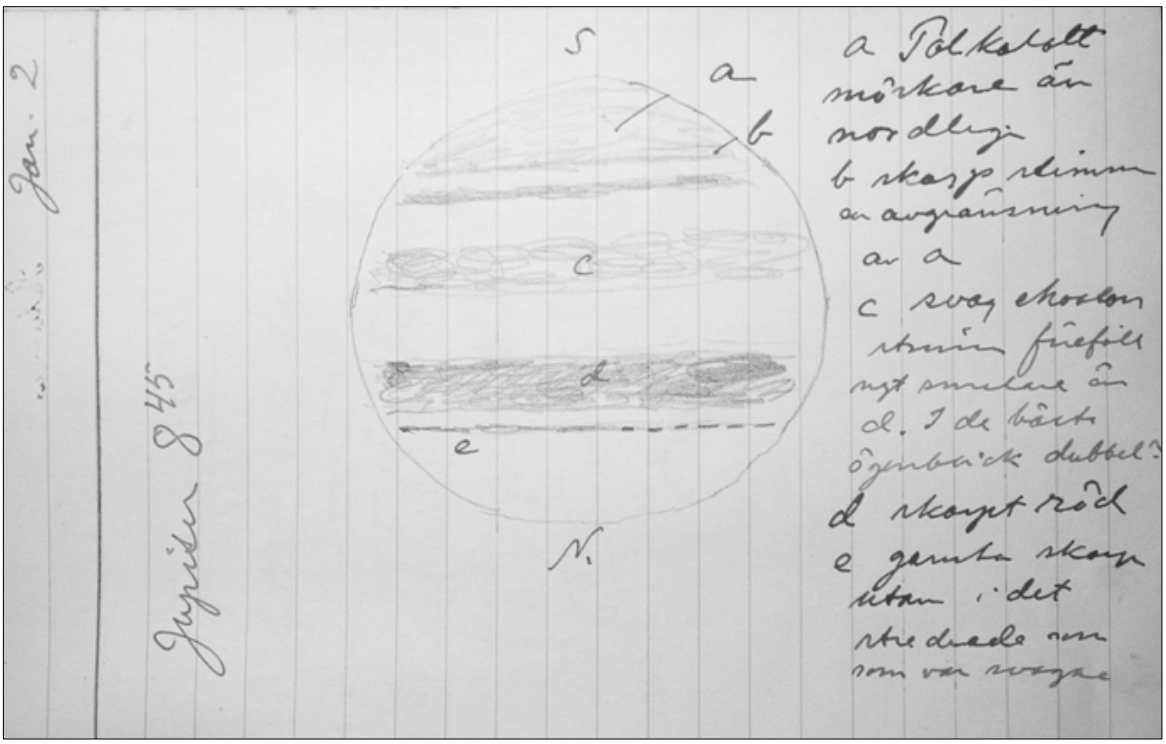


Figure 6: Wilhelm Norlind (1895–1982) was a Swedish amateur astronomer who specialized in planetary observing. His style of documenting observations often combined schematic drawings with verbal descriptions of shapes, colours, etc. He followed the changing aspects of Jupiter for decades, and this image, from the Norlind Collection in the Lund University Library, depicts a journal entry documenting an observation of Jupiter made in January 1942 (photograph: Gustav Holmberg).

for documenting observations at the telescope and a reduced permanent record, where observations of variables or comets, etc., are entered and reduced, during the day, when they are also sent on paper forms to organisations that collect and analyse such observations or, as has been common for quite some time now, entered in internet databases (Kärnfelt, 2015; Sidgwick, 1980: 285–288; Webb, 1962: 19; Westlund, 1992: 6). This is a bit like merchants, who have long kept two separate types of notebooks: a daybook recording transactions in chronological order, and a second notebook that sorts transactions into categories (Blair, 2004: 90ff).

Journals are also tools for historians of science who document the activities of amateur astronomers, particularly if they have a practice-oriented approach to history—just as laboratory notebooks and similar paper technologies are being pursued by historians of professional scientists (see Daston, 2004; Leong, 2018). Journals provide opportunities for the historian to understand the activities of an amateur astronomer or an observatory at an astronomy club, the technologies used, and the hardships and challenges inherent in amateur astronomy, or the observations that were made.

In a recent project on the history of amateur astronomy in Sweden during the twentieth century, journals kept by amateur astronomers, such as Nils Tamm and Wilhelm Norlind, and club observatories, such as the Tycho Brahe Observatory, have enabled a better understanding of the history of amateur astronomy (Holmberg and Kärnfelt, n.d.). Of course, there is a selection process that results in a bias towards advanced amateur astronomers (such as Tamm) who, even in their own lifetimes, were seen as leading amateurs, or amateurs with a propensity for archival storage of manuscript material (Norlind was a librarian at a university library). However, the preservation and utilisation of journals provides useful resources for examining the history of amateur astronomy (e.g., see Figure 6). Some amateur organisations are actively working to archive the observing journals of their members, a commendable practice (e.g. Report of the Council, 2014: 271).

Given that amateur astronomers have different styles of observation, various styles of journal-keeping are surely at hand. A more systematic comparison and analysis of observing journals from different observers, and how they developed over decades, is a suitable topic for further research into the information-handling of nineteenth and twentieth century amateur astronomy and, more generally, into what amateurs have been doing

while observing the sky.

Ending on a more personal note, by revisiting the pages of the observing journals that I kept as an active amateur astronomer, I can read not only about the documented observations of variable stars, sunspots and the occasional comet or deep sky object. Here and there I have provided short notes on the weather and local fauna, whether I was observing alongside friends from the local astronomy club, something about trying out a new telescope, or the challenge of keeping the telescope working, etc. Fond memories of nights long ago emerge from browsing these journals, together with strong feelings for the sky and for my identity and development as an amateur astronomer. Journals are an important part of being an observational amateur astronomer.

3 CONCLUDING REMARKS

This paper aims to explore how tangible and intangible heritage are interconnected. Our case being that of amateur astronomy, our discussion focuses on how amateurs in the recent past developed and employed paraphernalia associated with telescopes, and the environments in which they operated.

Our first case-study concerned different red-light techniques, which are necessary for navigating around the telescope while preserving dark adaption. Amateur astronomers have been at the forefront of developing red-light techniques based on pre-existing technologies.

Our second case discusses how the observer's eye is linked to the telescope using different types of eyepieces and associated accessories. It shows how improvements in eyepiece technology brought new observational opportunities and allowed amateurs to optimise their viewing experiences.

Lastly, our third case study, discusses journal keeping and paper technologies. While self-recording devices such as cameras now play a major role, for centuries hand-written notes and drawings were the amateur's main tool in recording observations and capturing experiences at the eyepiece.

Making sense of amateur astronomer's activities in the dark not only requires studying their instruments, but also examining the multiple accessories and practices that act as interfaces between the observer and the sky. These practices, or intangible heritage, are often rendered both tacit and ubiquitous by continuous practice over time. Accessing this intangible heritage through historic research provides valuable insights into observational practices, both past and present. This new and deeper understanding of the intangible is what motivated us to write this article.

The insights we gained have opened up new perspectives on the themes we were investigating. As we argued at the beginning of this paper, there are many more ways to access the culture of amateur astronomical paraphernalia and practices, such as active observation, replication and re-enactment, and handling physical objects to better understand the meanings and uses of astronomical equipment. There are more, of course—there are aspects of testing, maintenance and repair, for example, which we have not examined here. And how do amateur astronomers make their choices when they select—or abandon—their equipment? One might also enquire about the extent to which living memory is a requirement for understanding the histories of intangible heritage? And how can research into heritage beyond living memory be informed by work on more recent periods, like those presented here? Last but not least, how can we cross-fertilise these approaches to gain new and deeper insights? We look forward to future studies!

4 ACKNOWLEDGMENTS

We wish to express our gratitude for the many useful comments by the anonymous referees. We also wish to thank Klaus Soja for sharing his experiences with us; members of the Facebook group "Vintage Astronomy Books" for pointing out some important historical sources; the Tamm family for giving access to Nils Tamm's papers in the family archive; and our language editor Clare Barnes whose efforts have greatly contributed to the international presentability of this article.

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