Draft version September 22, 2014
Preprint typeset using LaTeX style emulateapj v. 12/16/11

150 YEARS AGO TODAY... NOTE ON THE VARIABLE NEBULA IN TAURUS

M. Usatov[1]

1. INTRODUCTION

In 1864, Monthly Notices of the Royal Astronomical Society – one of the world's leading research journals in astronomy and astrophysics – has published the following note by J. R. Hind, Esq. (Hind 1864):

> The night of the 12th of December last was one of the finest for telescopic observation here that I remember to have witnessed. It was on a similarly advantageous night (that of October 11, 1852) when the above nebula was discovered at Mr. Bishop's former observatory in the Regent's Park, and when it could not be overlooked with a low power on his 7-inch refractor. I have long been anxious, since the variability was detected, to examine the vicinity under the like favorable conditions, but, from one cause or another, have never succeeded until the above-mentioned date. On applying the same powers with which I saw it readily in 1852, and repeatedly distinguished it afterwards, when the sky was not so clear, I was unable to perceive the least trace of it: the star which formerly appeared almost to touch the nebula at its north-following limit, and which is also variable, was a 9.6 magnitude in Argelander's scale, or about as bright as in October 1852, but with the optical means at my command there was an entire absence of nebulosity in its neighbourhood. It is evidently an object deserving of continued attention at the hands of observers who are provided with instruments of great power. Mr. Talmage, whose sight is remarkably acute, and who, on the night in question, could distinguish eleven stars in the *Pleiades*, was equally unsuccessful with myself in discovering any trace of the nebulosity.
>
> *Mr. Bishop's Observatory, Twickenham,*
> *Jan. 7th, 1864.*

Tracing the origins of the discovery and the development of observations of NGC 1555, also referred to as the Hind's Variable Nebula in the constellation Taurus, reveal an interesting story of how a faint glow in the sky became on the most discussed objects in the sky.

2. JOHN RUSSELL HIND AND MR. BISHOP'S OBSERVATORY

John Russell Hind (May 12, 1823 – December 23, 1895) was born at Nottingham (Obi 1896). From as early as the age of six he was enthusiastic about astronomy, and by sixteen Hind was already contributing astronomical notes to the Nottingham Journal and other newspapers (NYT 1895). Hind received private education to become a civil engineer and then sent to London in order to assist a patent agent and consulting engineer. Following his tastes, Hind, however, remained at the office for a rather short time, and at the end of 1840 he has secured a position at the Royal Observatory in Greenwich. In 1844, Hind became an observer at George Bishop's observatory in Regent's park, London, becoming a Fellow of the Astronomical Society. This is where most of his discoveries were made. Although majority of his publications are related to asteroid or minor planet hunting and more focused on comets later in his life, Hind has contributed many of his observations of variable stars, Solar eclipses and photosphere, satellites of Jupiter and Neptune, rings of Saturn, transits of Venus and meteor showers. He became the President of the Royal Astronomical Society in 1880 and can be rightfully referred to as one of the finest observers of his time.

George Bishop (August 21, 1785 – June 14, 1861) was an English astronomer born in Leicester, a successful businessman. Later in his life, he turned to pursue scientific career when he was admitted to the Royal Astronomical Society in 1830, taking algebra classes and studying Laplace's "Mécanique Céleste". In 1836, Bishop has realized a dream of his life – he has constructed an astronomical observatory (Clerke 2004) at the South Villa of Regent's Park, one of the Royal Parks that lies within the inner North West London. (The park has been originally designed by the architect John Nash with a palace for the Prince Regent, later King George IV, and detached villas for his friends.) This is the place where Hind's Variable Nebula was first discovered in 1852 – see figure 1. This is exactly the place where Hind and Talmage took attempts to observe the nebula visually in 1863.

In *Astronomische Nachrichten*, one of the first international journals on astronomy, Hind wrote (Hind 1852):

> Last night (October 11) I noticed a very small nebulous-looking object in AR. $4^{\rm h}11^{\rm m}50^{\rm s}$ δ. $+19°8'$ for 1825, the epoch of our Ecliptical charts: it was south-preceding a star of 10th mag. which, to my surprise, has escaped insertion on the map for $4^{\rm h}$ R. A. recently published – possibly it may be variable. The sky at the time was remarkably clear but the object appeared very faint: it preceded the star $1^{\rm s}2$ and was $0'7$ south of it. I suppose it will prove a new nebula, none of our Catalogues having anything in the above position. Its diameter did not exceed $30'$.

[1] maxim.usatov@bcsatellite.net

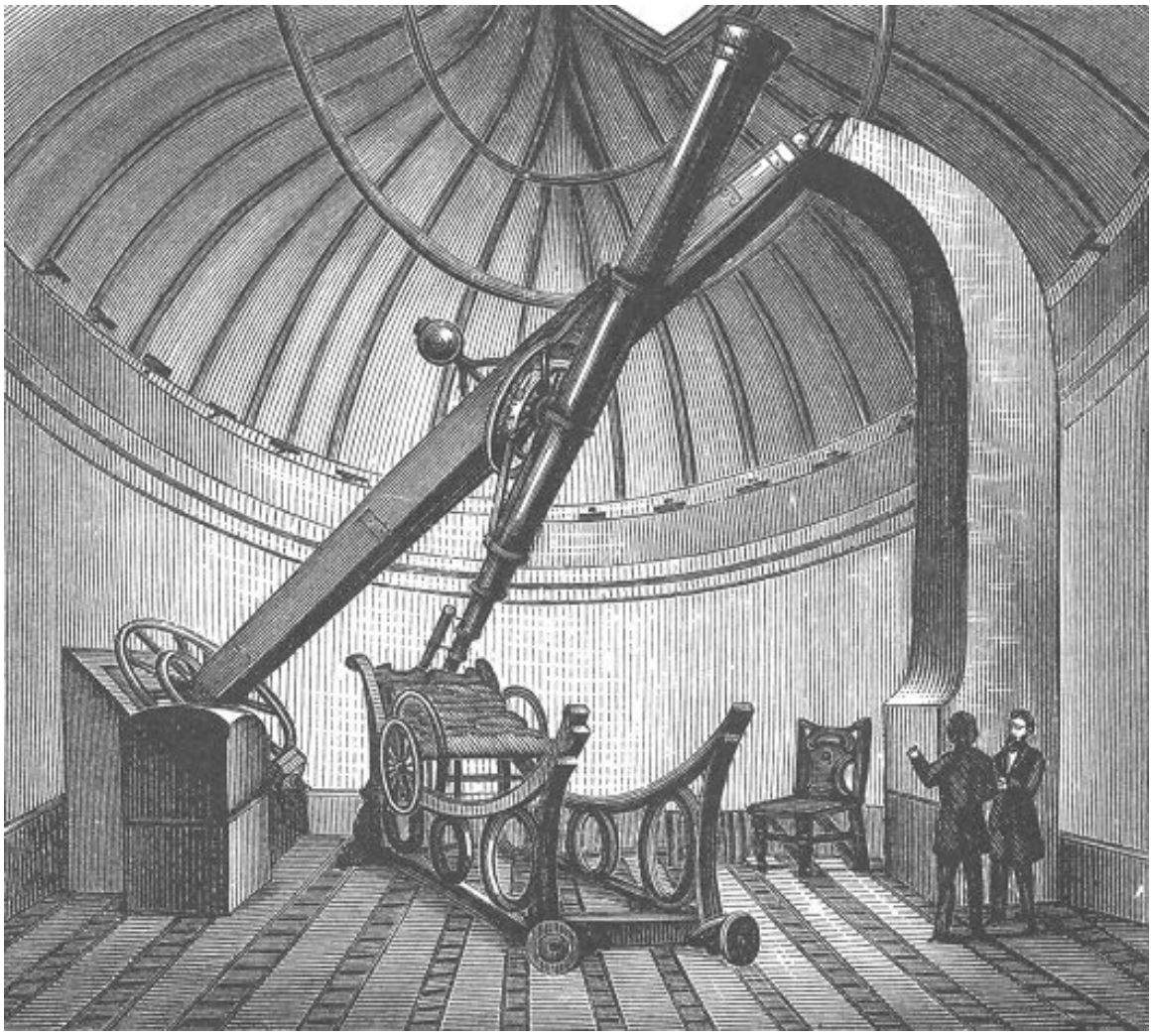

FIG. 1.— A print from *The Illustrated London News* from October 9, 1869 showing the interior of George Bishop's Observatory with $7''$ $f/18.4$ Dollond refactor that offered magnifications from 45X to 1200X (Steinicke 2010). It is worth to mention that this illustration is likely made after Bishop's death, once the observatory has been moved to the home of his son, George Bishop Jr. at Meadowbank, Twickenham.

What he saw at the Bishop's observatory was a reflection nebula – a cloud of interstellar dust that reflects the light of the nearby star T Tauri, however it would be long until astronomers will be able to explain the internal mechanics of this peculiar object and observe it with as much details as shown in figure 2. Since its discovery by Hind, many prominent astronomers, including d'Arrest, Struve and Lassell, have dedicated their attention to observing it and the area around T Tauri. At 1861, d'Arrest has found the nebula has disappeared. The 1863 observations by Hind and Talmage in Twickenham, as we have seen, confirm this. By 1868, the nebula could not have been seen even in the largest of the telescopes available at that time (Barnard 1899). In 1868, Struve observed another nebula $4'$ from the place of the Hind's, confirmed by d'Arrest. The new nebula has been assigned a separate catalogue number (NGC 1554) by Dreyer, however later dubbed "Struve's Lost Nebula" as it has disappeared later in 1877. Nearly 40 years after Hind's discovery, the nebula is "easily found" again via the $36''$ refractor in the Lick Observatory at Mount Hamilton, California (Burnham 1890). On that night, Burnham has reported a "very small condensed nebula" of $\sim 4''$ around the T Tauri star itself that was slightly elongated. Burnham and Keeler have examined this nebula with a small spectroscope, concluding it was most probably of the "usual gaseous type", reporting, however, that only the N II line was visible in its spectrum. The Hind's nebula disappears again a few years later (Barnard 1895):

> To my surprise no trace of Hind's nebula now exists—it seems to have entirely vanished! I have examined the place of this object several mornings lately under the very best conditions, but the variable nebula could not be seen. ... This proves my conjecture that this nebula still fluctuates in its light. It is certainly now invisible in the 36-inch. The place of this object should therefore receive careful attention with powerful telescopes to see when the nebula reappears.

FIG. 2.— NGC 1555, the Hind's Variable Nebula. December 2010 LRGB image by Adam Block via 32″ Schulman telescope at Mount Lemmon SkyCenter, University of Arizona. This image is licensed under a *Creative Commons Attribution – ShareAlike* 3.0 *United States License*. T Tauri appears orange, in the vicinity of the nebula. The view through the Hind's eyepiece in 1852 would have been very different – much fainter and without colors.

John Russell Hind died on December 23, 1895 at Twickenham.

3. INVESTIGATIONS

By this time, astronomical community was becoming ascertain on the variable nature of the Hind's nebula. Keeler was the first to initiate successful photographic observations of it, taking exposures of its faint irregular glow with the 36″ Crossley reflector at the Lick Observatory in 1899 (Keeler 1900). This was followed with more photographs made by Pease on the 60″ Hale reflector at the Mount Wilson Observatory during 1911–1919 (Pease 1917, 1920), revealing even more subtle details. Long after the World War I, Lampland, who has observed the Hind's nebula for more than 20 years with the 42″ reflector at the Lowell Observatory in Flagstaff, Arizona, has published a paper calling to continue observations (Lampland 1936). There he writes: "Hind's variable nebula near the well-known irregular variable star T Tauri is an object of unusual interest both on account of its history and the problems it presents. It appears to be the first nebula definitely shown by trustworthy observations to be variable." He complains on a discouragingly monotonous stretch of observing as the nebula was very faint. Baade and Hubble reported it could be seen visually again in a 100″ telescope (Herbig 1953). By 1935, Hind's nebula was notably increasing in brightness again and a photograph made in 1940 by Baade reveals a spectacular object with bright, overlapping arcs. In 1945, Joy proposes a new type of variable stars after their prototype – T Tauri, characterizing them as having irregular light variations of $\sim 3^{\mathrm{m}}$ with spectral type F5-G5 and emission lines resembling solar chromosphere, low luminosity and association with a nebulosity (Joy 1945). By 1951, Herbig reports the nebula became bright enough for visual observations, noting "it seems to have reappeared in a somewhat different shape than it had when bright a century ago." Nebula spectrograms obtained at that time make the association of its variability with the T Tauri evident as their spectra were identical. In his work, Herbig addresses a key question: what makes the nebula vary in light, given there is no correlation between the light variations of T Tauri and the nebula? He concludes this could be "a play of light and shadow on a relatively fixed curtain of dust clouds", that moving "condensation" is obstructing the light from T Tauri and making the nebula to disappear.

4. OUR DAYS

In SIMBAD, the T Tauri and Hind's Variable Nebula have more than 1,000 bibliographic references, most of them are on the variable itself. Throughout more than 150 years since its discovery by Hind, the nebula and T Tauri remain to be in the spotlight of the modern day astronomy. Providing a complete overview of the research record, including

all models suggested to explain peculiar brightness behavior, would not fit into the present work, however it would be a disservice not to mention a shift in the modern understanding of this region of the sky. 37 years after Joy proposed T Tauri to become a prototype for a specific subset of pre-main sequence stars right before they start thermonuclear fusion in their cores, a cool companion has been detected in infrared, close to the optically visible star, making it a binary system (Dyck et al. 1982). Among the class of young variable stars, T Tauri has became the least typical example of them, as it was put in the discovery paper, although today it is generally accepted that they are multiple systems. Just three years after, a faint third component has been confirmed (Nisenson et al. 1985). The kinematics of the region has been found to be very complex, and T Tauri is now considered to be a unique system (Stapelfeldt et al. 1998). The debates on its puzzling complexity continue to our days. The latest references on the T Tauri and Hind's Variable Nebula include a wide range of studies – from protoplanetary disks and the light echoes in YSOs, to the origin and evolution of stellar outflows, accretion mechanisms, magnetic field measurements, and many others.

This research has made use of the SIMBAD database, operated at CDS, Strasbourg, France.

REFERENCES

1895, Death Of John Russell Hind.; Career of a Celebrated Astronomer, Discoverer of Planets., New York Times
1896, MNRAS, 56, 200
Barnard, E. E. 1895, MNRAS, 56, 66
Barnard, E. E. 1899, MNRAS, 59, 372
Burnham, S. W. 1890, MNRAS, 51, 94
Clerke, A. M. 2004, in Oxford dictionary of national biography, ed. H. C. G. Matthew & B. H. Harrison, Vol. 05 (Oxford University Press)
Dyck, H. M., Simon, T., & Zuckerman, B. 1982, ApJ, 255, L103
Herbig, G. H. 1953, Leaflet of the Astronomical Society of the Pacific, 6, 338
Hind, J. R. 1852, Astronomische Nachrichten, 35, 371
Hind, J. R. 1864, MNRAS, 24, 65
Joy, A. H. 1945, ApJ, 102, 168
Keeler, J. E. 1900, MNRAS, 60, 424
Lampland, C. O. 1936, PASP, 48, 318
Nisenson, P., Stachnik, R. V., Karovska, M., & Noyes, R. 1985, ApJ, 297, L17
Pease, F. G. 1917, ApJ, 45, 89
Pease, F. G. 1920, ApJ, 51, 276
Stapelfeldt, K. R., Burrows, C. J., Krist, J. E., et al. 1998, ApJ, 508, 736
Steinicke, W. 2010, Observing and Cataloguing Nebulae and Star Clusters: From Herschel to Dreyer's New General Catalogue (Cambridge University Press)