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THE ASTRO-BIBLIO-STUDENTS PROGRAM

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Abstract. Many specialized libraries in different fields have lost their readers because of the decreasing number of new books, scientific journals or periodicals (economic reasons), and of the appearance of online digital journals and e-books (technological reasons). The Astronomical Library inside the Astronomical Observatory Cluj-Napoca, belonging to the *Babeş-Bolyai* University, faces this problem. To capture readers, especially students, the Astronomical Library together with researchers and professors decided to organize open days in which to present the library, publications in the library, as well as some current issues of observational and theoretical astronomy. Students who are interested in astronomy, or fascinated by the mystery of the sky have an increasing interest in the organization of open days at the Astronomical Observatory, especially if those days fall together with an interesting astronomical phenomenon, such as eclipses, occultations, comets, etc.

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1. INTRODUCTION

The National Library of Romania is the biggest library of the country. It is intended to be the repository of all that is published in Romania. The National Library is a cultural institution under the supervision of the Ministry of Culture. Its goal is to manage the national patrimony of publications, by purchasing and preserving documents and making them available to the public, for research or personal study.

The *Lucian Blaga* Central University Library of Cluj-Napoca serves the *Babeş-Bolyai* University. The library was founded in 1872, at the same time as the University of Cluj.

The Astronomical Library belongs to the Central University Library, and it can be found inside the Astronomical Observatory Cluj-Napoca. A librarian, who preserves the documents and makes them available for the public, works there. For economic reasons, this library mostly has documents from donations and access to some online publications. This is one of the reasons why the Astronomical Library lost over time a part of its reader community.

Today, in the Internet and computer era, most of the people think about libraries in the following way: why go to a library when you can access practically any book in the world with the touch of a button.

Following the above idea we could say that in the future probably we do not even know what a library really was, but we would be wrong. New research from the Pew Research Internet Project shows young Americans' reading and library habits [3]. The report brings together several years of research into how public libraries fit into the lives of young people aged 16 to 29 years old. This research is especially interesting now that access to information is increasingly becoming easier and digital-only. Moreover, it turns out that younger adults read just as much as the older generation.

Pew Research Internet Project found that young people are more likely to think that important information is not available online, to the tune of 62 percent of younger people compared with 53 percent of older Americans.

With more and more advances in technology, the community need for a library diminishes. Not only is this the case with the library's main purpose of lending out books when they are so easily available through digital methods, but this is also the reality in terms of a library as a social location within the community. Libraries are places where people can read, do research and study, but they are also places where meetings are held for community organizations, classes are offered and children can participate in creative and educational programs. As our lives become increasingly fast-paced and overrun by technology for leisure activities, people forget that the library has helpful social resources.

The survey from Pew Research Center brings this complex situation into stark relief ([3]). Many Americans say they want public libraries to:

- support local education;
- serve special constituents such as veterans, active-duty military personnel and immigrants;
- help local businesses, job seekers and those upgrading their work skills;
- embrace new technologies such as 3-D printers and provide services to help patrons learn about high-tech gadgetry.

Large majorities of Americans see libraries as part of the educational ecosystem and as resources for promoting digital and information literacy. Many Americans think closing their local public library would affect their communities, and one third say it would have a major impact on them and their families.

Moreover, a professional librarian helps the profession grow and remain relevant.

This research due to the Pew Research Center shows the librarians' situation in America. In Romania, as well as in Europe, the situation of libraries is the same. That is why we try to find a way to attract in our Astronomical Observatory and Astronomical Library more students and readers.

The best opportunity for the Astronomical Library is the Open Days, when a lot of curious people enter the Library to see the collection, and to read some new issues. During the Open Days people want to see what is happening in an Astronomical Observatory, so the Astronomical Library organizes presentations, workshops in library using books, journals and relevant documents.

This article deals with the problem of a weakened astronomical library and presents the Astro-Biblio-Students program as a posibility to improve this situation.

2. THE ASTRONOMICAL LIBRARY

The history of the Astronomical Library is intertwined with that of the Astronomical Observatory of the University of Cluj, built and equipped in the years 1920-1934. Professor Gheorghe Bratu, dean and vice-dean of the Faculty of Sciences and director of the Observatory between 1920-1923 and 1928-1941, is the first who ordered equipment and books, and Professor George Demetrescu (director of the Observatory between 1923-1928) completed these plans. The collections of books and periodicals of the library were enriched over the time, through the care of those who had leadership of this institution, and through the donations of specialized publications by the professors. Currently, the library's collections contain reference publications in this field, books and magazines, yearbooks, astronomical catalogues and stellar atlases, specialized dictionaries and encyclopedias. The Astronomical Library contains the necessary publications to develop the educational process and research. It is accessible mostly to students of the Faculty of Mathematics, Physics, Geography etc., master and PhD students in Astronomy, researchers in higher education institutions and researchers of the Romanian Academy.

The Astronomical Library contains 18,527 volumes, including 10,759 books, and 7,768 periodicals.

The Astronomical Library can be proud of a special publication, namely the *Astronomicum Caesareum*, by Peter Apianus, Edition Leipzig, 1967, which is the first reproduction in facsimile of the original writing in 1540.

Peter Apianus monograph, written in the spirit of Ptolemy's geocentric system, has a presentation in leather bond, with original manual coloring, and the 31.2 x 45.2 cm original format.

Nowadays this library becomes a deserted one, because of fewer people visiting and reading documents inside it. To stop the library unusability, we have joined our forces and gave presentations, workshops for different age groups within the framework of the special Open Days. In the following section we present the Astro-Biblio-Students Program, that can be used to resuscitate this weakened library.

3. THE PROPOSED METHOD

After many old libraries have lost a large number of their reading community, a question arises: what are the perspectives of an old library in the future? Our proposed method to help the library to be visited by a lot of interested people is the Astro-Biblio-Students program ([16]), which is elaborated for grade-school, high-school and college students.

The Astro-Biblio-Students program consists in six steps.

First step. The librarian will present the Astronomical Library, will tell stories about very interesting astronomical books and astronomers who changed the world.

Second step. The librarian will present some international and local relevant bibliography, documents for different branches of astronomy, such as fundamental astronomy, observational astronomy, astrophysics, cosmology, planetary science, astrobiology, archaeoastronomy, etc.

Third step. The main presentation in the Astro-Biblio-Students program will be made by a passionate astronomer, who will choose an interesting astronomical subject for the current events at the Open Days or at the special observational day (for example eclipses ([1]), transits, comets, satellites, etc. observation). We enumerate in the following some interesting astronomical subjects as chosen topic:

- The orientation on the sky ([17]; [18]);
- How do you find a constellation using a sky map?;
- The night sky and the daytime sky;
- Celestial coordinate systems;
- Conversion between celestial coordinate systems;
- The time;
- How to measure the distances between stars;
- The telescopes;
- Astronomical softwares ([19]);
- The Sun;
- Variable stars;
- The planets;
- Minor planets;
- Near Earth Objects;
- Artificial satellites;
- Archaeoastronomy ([2]; [4]; [5]; [11]);
- Astrobiology and exoplanets;
- The life on International Space Station (ISS);
- Cosmology;
- etc.

As an example we give a more detailed presentation from the topic *Conversion between celestial coordinate systems*, which needs basic mathematical knowledge, namely *Conversion between horizontal and equatorial systems.*

Just imagine that you are walking on a starry night, you are looking at the sky, and you notice a star, which for you is the most beautiful on the sky. Maybe you want to know where is the star in the sky, so that you can find your star in the future in the sky, and you could show to others your favourite star. Pretend all the stars are painted on the inside of a large ball, and you are at the center of the ball. The imagined ball is called the Celestial Sphere. First, the rotation of the Earth causes the imagined ball of stars to appear to

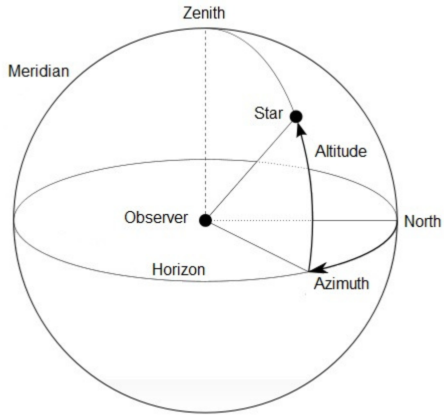

FIG. 3.1 – The horizontal coordinate system. The pole of the upper hemisphere is the zenith.

move around the sky. If you lay on your back (in the northern hemisphere) with your head to the north, the stars slowly slide by from left to right. There are two points however, where the stars do not appear to move: These two points are directly above the Earth's north and south poles. These two points, projected out into the sky are labeled the North and South Celestial Poles. To give your star position, you must know the coordinate parameters ([9]), for example the altitude of your star from a so called fundamental plane, and the azimuth measured from a fixed direction. The azimuth is measured from the north point (sometimes from the south point) of the horizon around to the east; the altitude is the angle above the horizon.

DEFINITION 1. The *horizontal coordinate system* is a celestial coordinate system that uses the observer's local horizon as the fundamental plane, and the primary direction towards north. It is expressed in terms of altitude (or elevation) angle and azimuth (Fig. 3.1).

In the horizontal coordinate system, the two independent horizontal angular coordinates are h (or z) and A:

- h - **Altitude** (Alt) or elevation is the angle between the object (in our case a star) and the observer's local horizon. It is an angle between 0 degrees and 90 degrees. Sometimes we use the zenith distance (z), the distance from directly overhead (zenith) to the star.
- z - The zenith distance is the complement of altitude ($z = 90° - h$).
- A - **Azimuth** (Az) is the angle of the object around the horizon, usually measured from the north increasing towards the east.

The horizontal coordinate system is sometimes also called the az/el system, the Alt/Az system, or the altazimuth system (from the name of the altazimuth mount for telescopes, whose two axes follow altitude and azimuth).

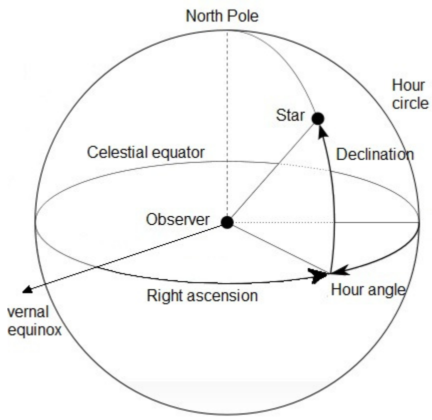

FIG. 3.2 – The equatorial coordinate system.

The horizontal coordinate system is fixed to the Earth, not to the stars. Therefore, the altitude and azimuth of our star in the sky changes with time, as the star appears to move across the sky.

In addition, because the horizontal system is defined by the observer's local horizon, the same object viewed from different locations on Earth at the same time will have different values of altitude and azimuth.

So, we must notice our position on horizon and the time. Maybe we want to show later our star to somebody, who is far away from our place. Then, we could not use the horizontal system.

But the horizontal coordinates are still very useful for determining the rise and set times of an object in the sky. When an object's altitude is 0°, it is on the horizon. If at that moment its altitude is increasing, it is rising, but if its altitude is decreasing, it is setting.

Another well known celestial coordinate system is the equatorial coordinate system.

DEFINITION 2. The *equatorial coordinate system* is a celestial coordinate system that uses the equatorial plane as the fundamental plane and a primary direction towards the vernal equinox. It is expressed in terms of declination angle and right ascension (hour angle) (Fig. 3.2).

In equatorial coordinate system the two angular coordinates are δ and α (or H):

- δ - the **declination** (abbreviated: Dec) measures the angular distance of an object (in our case a star) perpendicular to the celestial equator, positive to the north, negative to the south. For example, the north celestial pole P has a declination of $+90°$.
- α - the **right ascension** (abbreviated: RA) measures the angular distance of an object eastward along the celestial equator from the vernal equinox to the hour circle passing through the object. The

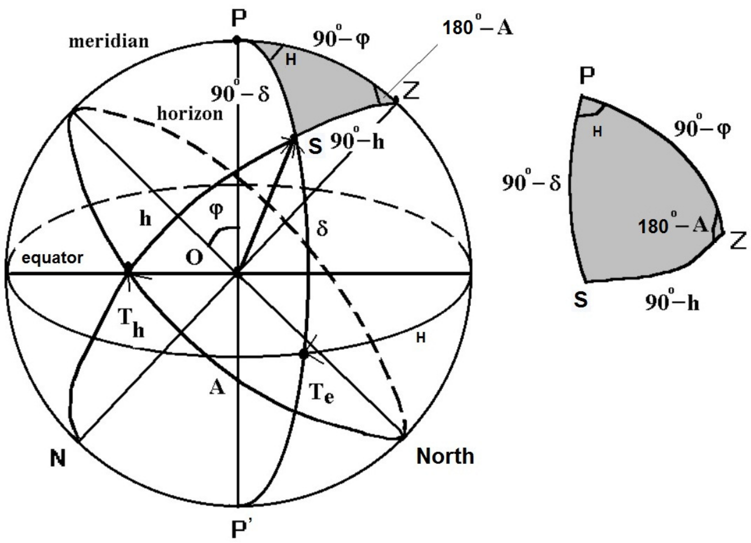

FIG. 3.3 – The horizontal and equatorial coordinate system. The astronomical triangle SPZ.

vernal equinox point is one of the two where the ecliptic intersects the celestial equator. Right ascension is usually measured in sidereal hours, minutes and seconds instead of degrees, $(360°/24\ \text{h}) = 15°$ in one hour of right ascension.

- H - hour angle alternatively to right ascension (abbreviated: HA or LHA) measures the angular distance of an object westward along the celestial equator from the observer's meridian to the hour circle passing through the object.

Notice that the system does not depend on where you are standing on Earth, nor on the time of day. If you have a Right Ascension and a Declination, you have an unambiguous spot specified on the Celestial Sphere.

To convert between the horizontal and equatorial coordinates for an object S (in our case a star), we use a spherical triangle often called the Astronomical Triangle: SPZ, where Z is the zenith, P is the North Celestial Pole, and S is the object (Fig. 3.3). The sides of the triangle are:

- PZ is the observer's co-latitude, $PZ = 90° - \varphi$.
- ZS is the zenith distance of S, $ZS = 90° - h$.
- PS is the North Polar Distance of S, $PS = 90° - \delta$.

The angles of the triangle are:

- The angle at P is H, the local Hour Angle of S.
- The angle at Z is $180° - A$, where A is the azimuth of S.
- The angle at S is q, the parallactic angle.

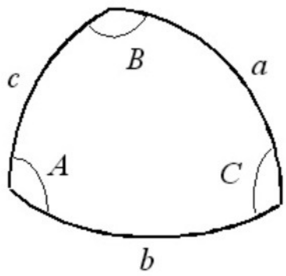

FIG. 3.4 – The polar triangle **ABC**.

NOTATION 1. The astronomical triangle or polar triangle SPZ is called *parallactical triangle* in case of the conversion between horizontal and equatorial coordinates. The parallactic triangle can also be used to determine the times and azimuths of the risings and settings of celestial bodies (in this case $z = 90°$) and to compute the time of onset of twilight.

By applying the formulas of spherical trigonometry to the parallactic triangle, we can find the equatorial coordinates H and δ of the point, in our case the star S, from the point horizontal coordinates A and h, and vice versa.

Let us write first the *spherical law of sines* or *sine formula.* In the spherical case, the formula is:

$$\frac{\sin a}{\sin \mathbf{A}} = \frac{\sin b}{\sin \mathbf{B}} = \frac{\sin c}{\sin \mathbf{C}}. \tag{1}$$

Here, **A**, **B**, and **C** are the angles of an spherical triangle **ABC**, and a, b, c are the surface angles opposite their respective arcs (see Fig. 3.4). Applying the spherical law of sines for angles $\mathbf{A} = H$ and $\mathbf{B} = 180° - A$, and arcs $a = 90° - h$, $b = 90° - \delta$ in the astronomical triangle SPZ, after simplification, we obtain:

$$\cos \delta \sin H = \cos\, h \sin A. \tag{2}$$

Now, let us write the *sperical law of cosines* or *cosine formulas.* In the spherical case, in the same polar triangle **ABC**, the formula is:

$$\cos a = \cos b \cos c + \sin b \sin c \cos \mathbf{A}. \tag{3}$$

Applying the spherical law of cosines for angle $\mathbf{A} = H$ and arc $a = 90° - h$, and then for angle $\mathbf{A} = 180° - A$ and arc $a = 90° - \delta$ in the astronomical triangle SPZ, after simplification, we obtain:

$$\begin{aligned} \sin\, h &= \sin \delta \sin \varphi + \cos \delta \cos \varphi \cos H, \\ \sin\, \delta &= \sin\, h \sin \varphi - \cos\, h \cos \varphi \cos A. \end{aligned} \tag{4}$$

The third spherical law is the *analogue formula* (see [9]). In the spherical case, in the same polar triangle **ABC**, the formula is:

$$\sin a \cos \mathbf{B} = \cos b \sin c - \sin b \cos c \cos \mathbf{A}. \tag{5}$$

Applying the analogue formula for angles $\mathbf{B} = H$, $\mathbf{A} = 180^\circ - A$, and side $a = 90^\circ - \delta$, and then for angles $\mathbf{B} = 180^\circ - A$, $\mathbf{A} = H$, and side $a = 90^\circ - h$, in the astronomical triangle SPZ, after simplification, we obtain:

$$\begin{aligned} \cos\,\delta\,\cos H &= \sin\,h\cos\varphi - \cos\,h\sin\varphi\cos A, \\ \cos\,h\,\cos A &= -\sin\delta\cos\varphi + \cos\delta\sin\varphi\cos H. \end{aligned} \tag{6}$$

To convert from equatorial to horizontal coordinates, we have the formulas:

$$\begin{aligned} \cos\,h\sin A &= \cos\delta\sin H, \\ \sin\,h &= \sin\delta\sin\varphi + \cos\delta\cos\varphi\cos H, \\ \cos\,h\,\cos A &= \cos\delta\sin\varphi\cos H - \sin\delta\cos\varphi. \end{aligned} \tag{7}$$

To convert from horizontal to equatorial coordinates, we have the formulas:

$$\begin{aligned} \cos\delta\sin H &= \cos\,h\sin A, \\ \sin\,\delta &= \sin\varphi\sin\,h - \cos\varphi\sin\,h\cos A \\ \cos\,\delta\,\cos H &= \sin\,h\cos\varphi + \cos\,h\sin\varphi\cos A. \end{aligned} \tag{8}$$

Notation 2. Having calculated H, ascertain the Local Sidereal Time s (local time scale that is based on the Earth's rate of rotation measured relative to the fixed stars; we define local sidereal time (LST) to be 0 hours when the vernal equinox is on the observer's local meridian).

Then the right ascension follows from relation $\alpha = s - H$.

Right ascension and declination tell where the telescope is pointed. So, when we use a telescope to find our star, then we will use the equatorial coordinates, and now we can convert from the horizontal coordinates the equatorial coordinates.

Fourth step. This consists in a workshop, in which together with the librarian we make an application for the chosen topic. At this stage the librarian prepares the relevant books and documents. For our presented topic, as an application, we can measure the horizontal coordinates of an object in the sky; then using the conversion between horizontal and equatorial systems we give the measured data in the equatorial system, and viceversa (see [6]; [7]; [8]).

We can check the results through the application of sky map programs like Stellarium software. For example let us consider the star Vega. The practical example for college students could be calculated on paper, and for others could be presented on a computer program. We take the equatorial coordinates from the SIMBAD star catalogues for epoch 2000 ([20]): $\alpha = 18^h36^m56.33635^s = (18{+}36/60{+}56.33635/3600)^h = 18.6156^h = 279.23^\circ$ and $\delta = 38^\circ47'01.2802'' = (38 + 47/60 + 1.2802/3600)^\circ = 38.7837^\circ = 38.7837^\circ\frac{\pi}{180^\circ} = 0.6769$ radians. These can be programmed into computerized telescope mounts, which can then find and track the star as it moves with the earth's rotation.

We calculate the horizontal coordinates A and h for the moment 15th November, 2015, $t = 22^h$ local time at Cluj-Napoca (latitude $= 46^\circ46' =$

46.766° = 0.8162 radians, longitude= $23°36' = 1^h34^m24^s = 1.5733^h$). We give the local sidereal time: $s = 2^h12^m26.2^s$, and knowing the right ascension, we obtain the hour angle: $H = s - \alpha = 7^h35^m30^s = 7.5917^h = 1.9876$ radians. Now, we can apply the system of equations (7), which convert from equatorial to horizontal coordinates:

$$\begin{aligned}\sin h &= \sin(0.6769)\sin(0.8162) + \cos(0.6769)\cos(0.8162)\cos(1.9876),\\ \sin A &= \cos(0.6772)\sin(5.6418)/\cos(0.2425)\end{aligned}$$

We get for the altitude $h = 0.2425$ radians $= 13°54'$ and $A = 0.8246$ radians $= 47{\cdot}2460°$, where the real azimuth is $Az = 360° - A = 312°45'$.

For testing our results we can search for the star Vega in the Stellarium Mobil Sky Map program. We can see the star Vega westward on the sky, setting down, near the horizon. It is set down after midnight. Vega (α Lyr) is the brightest star in the constellation Lyra and the fifth brightest star in the night sky. It is a variable star. (At this step we can give more interesting details about the object.)

Fifth step. This consists in the real observations on the night sky of the calculated objects. We can find the star Vega, which is located close to the zenith.

Sixth step. A discussion on the chosen topic will end the session. At this stage we get feedbacks on the chosen topic and on the presentation, and identify workshop ideas for the future.

Going through these six steps in the presentation of Astro-Biblio-Students program any library can improve the rate of visitors.

4. CONCLUSIONS

Our idea to ressurect a weakened library makes a major change in a librarian and a library life, especially the *working team* being very important. The librarian works together with university professors, academics, lecturers, assistents, researchers, students, etc.

Astro-Biblio programs can be adjusted with adequated open days programs for *other specialized libraries* as mathematical, physical, chemical, biological, geographical, etc.

We developed different Astro-Biblio programs for *kids, students and adult people* (see [10]; [12]; [13]; [14]; [15]; [16]). The astronomical knowledge transfer begins at early childhood and continues until the older age. The sky enchanted many people, from small children to old persons.

Now, when the astronomical knowledge evolves very quickly due to the modern technology, it is very important to educate people in the right way, applying different didactical methods such the Astro-Biblio program for all the age groups.

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