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Scope and Training for Amateur Astronomers in Developing Countries to Contribute to Astronomical Discovery

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Abstract

Developing countries like India have a huge population already trained to the level of basic schooling, but there is little awareness about astronomy in the society at large. The basic capabilities required for arduous work leading to an astronomical discovery exist but there is a lack of awareness, knowledge and confidence about the subject.

Past data show that simple techniques can lead to Astronomical Discovery. Significant discoveries have been made in the past by dedicated amateur astronomers in fields such as comets, novae, supernovae, variable stars and asteroids.

As a science writer, speaker and researcher, I would like to discuss the challenges and opportunities that exist for young people (aged up to 30) in India and similar countries to make astronomical discoveries. The paper discusses methods to motivate and guide young people to make astronomical observations with small telescopes, perhaps ultimately leading them to a discovery.

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1. Introduction

Astronomy can be considered as a most popular scientific subject among the masses. Virtually every citizen of any country has watched the stars and the planets with awe and wonder. But few give a thought about their origin, and few have fallen in love with the heavens so much so that they have become life-long star-gazers. Amateur astronomers are those who carry out astronomy with a high degree of skill, but not for pay[1, 2]. The contribution of amateur astronomers to research is well known. In today's modern world with the availability of high-end technology at our fingertips few of this breed have converted themselves into ProAms, "the professional Amateurs" doing "A" class work in Astronomy. Most of these highly skillful and passionate people work independently, spending from their own pockets or seldom on meager grants received by private agencies or groups.

Past data have shown that many discoveries in Astronomy are made by dedicated amateur astronomers[3]. Comets, Variable stars, Asteroids, Novae and Supernovae are the potential fields of discovery. To make a discovery in any of the above-mentioned fields need a specific kind of equipment, efforts, skill and knowledge. Excellent sky-conditions and burning desire to be a discoverer are "a must" similar to any field of observational research.

Although developing countries like India have a high potential to make discoveries, the reality is quite different. The existing data show that hardly any Indian amateur astronomer has made a significant discovery in the field of observational astronomy from the Indian subcontinent in the past. The reasons are manifold and the challenges are hard but there can be different solutions. Simple techniques can be devised and utilized to motivate the younger generation to explore the universe in a different way. Having worked with young amateur astronomers for more than two decades in India, I have many observations and data to share. This paper describes them in appropriate detail.

2. Initial observations

1. Discovery of a comet, nova, supernova, variable star or an asteroid is very crucial from a scientific point of view. Every discovery adds value in its own way into the human understanding of the universe. The distance of the objects from the earth doesn't matter in the process of discovery if one learns the "tricks of the trade" and uses appropriate techniques and equipments.
2. All the above mentioned objects are very dissimilar as far as physical characteristics are concerned and to discover their new member needs different techniques, aptitude, instrumentation, sky-conditions and degree of efforts.

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3. The astronomical discovery is very unpredictable as one can imagine. Therefore it is possible that one might not discover anything in one's long observing tenure. The risk can be minimised by persevering with the right aptitude, instruments and past experiences.
4. The discoverer may need to spend from his/her "own pocket" for the appropriate devices and instruments. This may hamper the program. There is no guarantee that any government or private body may reward the discoverer for his/her discovery.
5. In a country like India, there is no network of private observatory "owners" or "colleagues" to check for the suspected objects as potential discoveries.
6. For an amateur to be a discoverer certain level of training is required. The training might not be very expensive or advanced. Basic training and initial guidance is a must for each observer.
7. To be a discoverer dedication, determination and perseverance are the personal essential qualities
8. A motivation to be a "discoverer" is a key to success
9. Dark sites and appropriate instruments are necessary as a fundamental requirement to each discoverer
10. Simple techniques and simple language instructions are needed leading from patrol to a discovery.

3. Current situation in India

There are many peculiar points to note about the current youth and its inclination towards fundamental sciences in the countries like India.

1. The population of India's youth, age from 16 to 24 is nearly 200 million in 2010[4].
2. In the state of Maharashtra 1.2 million students cleared their schooling till 10th standard in 2009[5]. Considering 28 states and 7 union territories in India, millions of children complete their schooling in India every year.
3. These children are well-versed with English language (reading and writing), basic math skills (arithmetic, algebra and geometry) and school level physics. They have appeared for these subjects for 100 marks or more. Many are very bright in academics obtaining more than 80% marks.
4. No school in India has Astronomy as a separate subject. The students do not get any exposure to the subject in the school. There is lack of awareness among the children, parents and school teachers about Astronomy in general and discoveries in particular.
5. There are no efforts from government or astronomy outreach bodies to develop skills among the youngsters which will lead them to astronomical discovery

6. The amateur astronomy clubs lack the knowledge of appropriate instruments, devices and references required for the task.
7. There is in general tremendous interest among the masses about astronomy and sky-watching.
8. There are more than 100 amateur astronomy clubs in the country but none is specialized in a particular discipline in Astronomy.
9. Very few universities offer a course on Astronomy at undergraduate level (Bachelors level).
10. There are no social "incubators" to "keep alive" the sense of wonder and interest of the youngsters about the starry night and the fascinating science behind it.
11. There is a strong belief in the society that discoveries are the premises of very "top-notch" professionals and crazy scientists. So students should not venture into it but concentrate only on their academics.
12. Few astronomy awareness efforts are successful but they are event specific, like total solar eclipse[6], apparition of comets, a Leonid meteor shower or opposition of a planet like Mars.
13. There are many places in the country where good dark sky is still available. The areas are mostly remote and lack any basic facilities.
14. The Indian Space Program is a major boost in creating some awareness in the society about space and astronomy[7].
15. The current picture is mixed with favorable and unfavorable aspects. There are many challenges which are discussed later. Although the overall scene looks bleak there are hopes. There can be many opportunities which one needs to identify and tap. This scene is more or less everywhere in Asia with exception of Japan. Japanese have consistently proved themselves by manufacturing excellent optics for astronomy and making many discoveries of asteroids, comets, novae and supernovae[8].

4. Opportunities in India

India is a developing country. There are many opportunities which can be the future potential for astronomical discoveries.

1. Abundant human resources are available in India. There is a great opportunity for selection of the candidates if a serious program of astronomical discovery is planned.
2. India is a large country and there are many excellent dark sites "alive" today waiting to be discovered.
3. Communications with the youngsters is in English and is standardized. Most of the school children speak very well in English and can write it well[9].

4. Telecommunications facilities, like internet and mobile have penetrated into the villages of the nation and so virtually everyone is accessible and connected.
5. Computer literacy is increasing at rapidly, and is taught as a separate subject in all the government and private schools from 3rd standard onwards. In some schools it is taught from 1st standard. A desktop computer is no more a luxury but a necessity in all schools and most of the urban homes in India today.
6. Children are inquisitive and energetic in general and they can be molded and fine tuned to make an astronomical discovery at a young age (below 22 years)

5. Challenges

Although India has a large potential and opportunities there are many challenges to overcome successfully.

1. A nationwide astronomy discovery program for amateur astronomers needs to be designed and implemented. Government or an established private agency can take a lead in this process.
2. Selection of the appropriate candidates needs to be based on primarily on the following criteria:
    a. Very high level of self-motivation
    b. Dedication in terms of time and efforts
    c. Willingness to work hard and persevere in efforts for years with low probability of success
3. A workable observation program for each individual as per his/her taste and aptitude is necessary.
4. The country lacks proper availability of instrumentation[10] needed for astronomical discovery program.
5. Astronomy awareness level is below average and needs to be nurtured properly.
6. Centralized collation of results of the observations is necessary
7. Today the country doesn't have a single private observatory and the government observatories are not accessible for observations to amateurs so there is no guidance and support available for the dedicated amateurs from the senior amateur astronomers or professional-amateur (Pro-Ams)[11] astronomers. This breed of astronomers is needed to crosscheck the results of potential discovery prior sending to CBAT.

6. Instrumentation/equipment required for astronomical discovery

The equipment required for astronomical discovery varies with the type of celestial object under investigation. Because of advances in technology there is a vast choice to suit individuals taste

and preference. The basic instruments needed to start the discovery program are listed in the table. This can be considered as a general guideline for the observers entering in to the field of astronomical discovery. Four objects are considered. They are novae, supernovae, comets and asteroids.

No.	Celestial Object	Visual Hunting	Photographic Hunting
1	Novae	• Field charts (especially 15^0 of both the sides of Galactic equator)[13,16] • Planetarium software which can show stars of 16^{th} magnitude and higher • 10 X 50 or higher aperture binoculars with sturdy Alt-Az mount • A reclining chair with neck rest	• Field charts (especially 15^0 of both the sides of Galactic equator) • Planetarium software which can show stars of 16^{th} magnitude and higher • Excellent quality German equatorial sturdy motorised mount • DSLR camera with shutter release cord • Wide field lens with appropriate adapter • Image processing software and computer
2	Supernovae	• Field charts (Thompson-Bryan Supernova Search Charts)[12] • Planetarium software which can show stars of 16^{th} magnitude and higher • Astronomical telescope showing stars of 14^{th} magnitude or higher • Excellent quality sturdy mount	• Field charts (Thompson-Bryan Supernova Search Charts) • Planetarium software which can show stars of 16^{th} magnitude and higher • Astronomical telescope showing stars of 14^{th} magnitude or higher with a fast focal ratio of f/6 to f/8. • Excellent quality German equatorial sturdy motorised mount • Thermo-cooled CCD camera with appropriate adapter • Image processing software and computer
3	Comets	• Field charts[13] • Planetarium software which can show stars of 16^{th} magnitude and higher • Astronomical telescope showing stars of 12^{th} magnitudes and higher[14] • Sturdy Alt-Az mount	• Field charts • Planetarium software which can show stars of 16th • magnitude and higher • Astronomical telescope showing stars of 12^{th} magnitudes and higher • Excellent quality German equatorial sturdy motorised mount • Thermo-cooled CCD camera with appropriate adapter • Image processing software and computer
4	Asteroids	• Field charts[15] • Planetarium software which can show stars of 16^{th}	• Field charts (especially 15^0 of both the sides of Ecliptic) • Planetarium software which can show stars of 16^{th} magnitude and

		magnitude and higher • Astronomical telescope showing stars of 12th magnitudes and higher[14] • Sturdy Alt-Az mount	higher • Astronomical telescope showing stars of 12th magnitudes and higher • Excellent quality German equatorial sturdy motorised mount • Thermo-cooled CCD camera with appropriate adapter • Image processing software and computer

7. Simple procedure(s) for making an astronomical discovery

Following are the simple procedures devised and fine tuned by many successful amateur astronomers. There can be some minor variations as per the individual but they can be used as standard guidelines.

7.1 Visual nova hunting procedure is as follows:

1. Identification of the observer's location
2. Identification of the best part of the sky near Galactic equator visible from the location throughout the year
3. The sky which is 15^0 above horizon needs to be considered as better for useful observations
4. Splitting the sky into small parts for ease of observations
5. Observation of each sky "patch" with good quality 10x50 or higher aperture binoculars for any new "visitor"
6. Making the drawings of what is seen and not "what is in the map" (one's own constellations)
7. Observation records of the faintest star magnitudes possible (stellar magnitude of +9.0 and higher is preferable)
8. Observation records taken for each and every cloudless night
9. Identification of the discrepancies and confirmation of the false alarms
10. Information to CBAT regarding "real" potential candidates[17]

7.2 Photographic nova hunting procedure is as follows:

1. Identification of the observer's location
2. Identification of the best part of the sky near Galactic equator visible from the location throughout the year
3. The sky which is 150 above horizon needs to be considered as better for useful observations
4. Splitting the sky into small parts for ease of observations
5. Photographing the sky patches using wide angle lens and a CCD or DSLR camera mounted on motorised equatorial stripod
6. Maintaining the images for comparison with the previous images taken of the same part of the sky for any new "visitor".
7. Observation records taken for each and every cloudless night
8. Identification of the discrepancies and confirmation of the false alarms
9. Information to CBAT regarding "real" potential candidates

7.3 Visual supernova hunting procedure is as follows:

1. Identify the galaxies which rise above 15^0 in the locan sky. The galaxies can be of all types although historical data shows that Sc type of spirals are more prone to new supernovae discoveries
2. Observation of the selected galaxies with a telescope whose limiting magnitude is 14 or higher
3. Observation frequency can be once or twice in the month.
4. Compare the galaxies with that of standard galaxy catalogues like Thompson-Bryan Supernova Search Charts
5. Identification of the discrepancies and confirmation of the false alarms
6. Information to CBAT regarding "real" potential candidates

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7.4 Photographic supernova hunting procedure is as follows:

1. Identify the galaxies which rise above 15^0 in the locan sky. The galaxies can be of all types although historical data shows that Sc type of spirals are more prone to new supernovae discoveries
2. Photography of each galaxy with an astronomical telescope and thermocooled CCD camera which records the stars upto 14^{th} magnitude and higher
3. Observation frequency can be once or twice in the month.
4. Comparison of the photographs with the images of standard galaxy catalogues like Thompson-Bryan Supernova Search Charts
5. Identification of the discrepancies and confirmation of the false alarms
6. Information to CBAT regarding "real" potential candidates

7.5 Visual hunting of comets:

1. Observation of the sky prior sunrise and after sunset for potential sun-grazing comets
2. Observations of "comet haystack region"[18] are necessary.
3. Observations with an astronomical telescope showing stars up to 12^{th} magnitude or higher
4. Making the drawings of what is seen and not "what is in the map" (one's own constellations)
5. Observation records of the faintest star magnitudes possible (stellar magnitude of +9.0 and higher is preferable)
6. Observation records taken for each and every cloudless night
7. Observations for any new "visitor"
8. Identification of the discrepancies and confirmation of the false alarms
9. Information to CBAT regarding "real" potential candidates

Note: Discovery of the comets is possible now on internet[19].

7.6 Photographic hunting of comets:

1. Observation of the sky prior sunrise and after sunset for potential sun-grazing comets
2. Deep sky photography at cloudless nights

3. CCD or digital photographing using astronomical telescope showing 12th magnitude or higher stars. A wide angle lens can be used as well.
4. Photographing the "comet haystack region".
5. Comparing the images with the images of standard or photographic star atlases
6. Checking for potential candidates
7. Identification of the discrepancies and confirmation of the false alarms
8. Information to CBAT regarding "real" potential candidates

7.7 Visual hunting of the asteroids:

1. Identification of the observer's location
2. Identification of the best part of the sky near Ecliptic visible from the location throughout the year
3. The sky which is 15^0 above horizon needs to be considered as better for useful observations
4. Splitting the ecliptic region in to small parts for ease of observations
5. Observations using an astronomical telescope which can show 12th magnitude stars or higher
6. Comparison of the sky visible with an excellent sky atlas for identifying a new object.
7. Observation of the suspected objects for few hours to check their motion
8. Identification of the discrepancies and confirmation of the false alarms
9. Information to CBAT regarding "real" potential candidates

7.8 Photographic hunting of the asteroids:

1. Identification of the observer's location
2. Identification of the best part of the sky near Ecliptic (15^0 either side) visible from the location throughout the year
3. The sky which is 15^0 above horizon needs to be considered as better for useful observations
4. Dividing the sky in to small "patches"
5. Photographing the sky with an astronomical telescope and a thermo-cooled CCD camera. The image should reflect stars of 12th magnitude and higher. A wide angle lens can be used as well
6. Comparing the images with the standard or photographic star atlases

7. Observation of the suspected candidates for few hours to check their motion
8. Confirmation of the false alarms
9. Information to CBAT regarding "real" potential candidates

8. **Conclusions**

1. A significant fraction of the comets, novae and supernovae has been discovered by passionate amateur astronomers of different countries

2. Developing countries like India have a great potential at grass root level to make many astronomical discoveries

3. There are some challenges and many opportunities in the country like India for making astronomical discoveries

4. Discovering novae and supernovae is a very challenging and fulfilling task

5. To find highly motivated and dedicated observers is a challenging task

6. Small task force of amateurs may give more successful results than a large group of "intermittant" astronomers

7. Meteor showers, comets, asteroids, novae and supernovae are very motivating objects in the sky...They can be "cashed on" by creating a mechanism to attract more youngsters to this fascinating field of science.

8. The astronomical discovery process is not a money-making activity. So the observers involved need to be financialy stable to contribute on a long term basis. IN the developing countries is can be a challenge as there is an unemployment issue, and no "unemployment allowance" is available.

9. The observational discovery process can be a slow moving activity. SO appropriate timelines need to be set for fruitful results.

10. For each kind of object a specific set of instruments is necessary for success.
11. Dark sky is the most basic necessity to carry our the discovery programm.

Further Reading

AAVSO nova hunting guidelines
AAVSO supernova search manual
BAA nova hunting guidelines
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