Part II

Observational Methods

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

Amateur Astronomers and the IAU Central Bureau for Astronomical Telegrams and Minor Planet Center

Brian G. Marsden
Harvard-Smithsonian Center for Astrophysics, 60 Garden Street,
Cambridge, MA 02138, U.S.A.

Introduction

Of all the sections of the International Astronomical Union the Central Bureau for Astronomical Telegrams is undoubtedly the one that most concerns amateur astronomers. Just about anybody in the world with at least some familiarity with the sky has the potential to discover (or to think he or she has discovered) a comet or nova. If the object is real and sufficiently bright, it is very probably already known. Somebody has to be the first discoverer of every comet or nova, however, and soon after the IAU was established in 1919 it set up the Central Bureau to receive and to disseminate to the astronomical community news of such discoveries. Discoveries of supernovae in other galaxies, natural satellites of the planets, erupting x-ray sources and transient features on the planets are also dealt with by the Central Bureau, which since 1965 has operated at the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts. The Central Bureau handles unusual minor planets in the vicinity of the earth, although the thousand or more ordinary minor planets routinely discovered each year (and with which amateurs are being increasingly involved) are more appropriately the province of the Minor Planet Center, set up by the IAU in 1947 and since 1978 also operated at the Smithsonian Astrophysical Observatory. About one-quarter of the subscribers to the various services of the Central Bureau and/or the Minor Planet Center are individual amateur astronomers or organizations of amateurs.

Discoveries

Comets. Throughout its history the dominant function of the Central Bureau has been the announcement of discoveries of comets. Both professional and amateur astronomers are involved in this activity, and it is perhaps of some interest to examine the relative contributions of these groups. The upper curve in Fig. 1 shows the total number of new comets discovered each year during the two-thirds of a century since the IAU was founded, and the lower curve shows the number of discoveries that were made by amateurs.

To eliminate the most dramatic variations from one year to the next and the indeterminacy that would otherwise occasionally arise in the computation of the relative amateur contribution, the plot actually gives annual values smoothed over

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

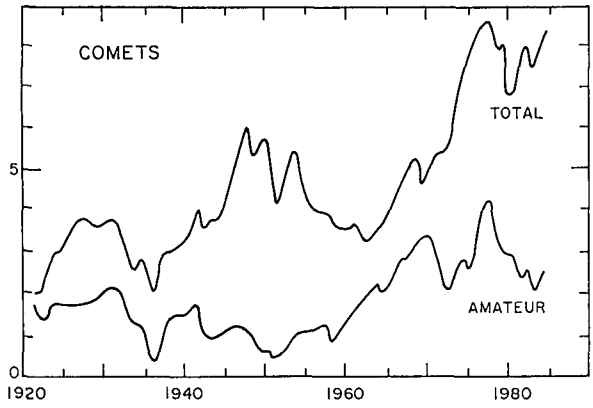

Fig. 1. The upper curve shows the total number of comets discovered per year, the lower curve the number found by amateurs. Values are smoothed over 5-year spans.

five-year spans. Accidental rediscoveries of periodic comets are included, but comets for which orbits could not be computed or which were not found until some years after the records of them were actually obtained are not. A comet can be credited to as many as three discoverers, and it is classified here as an amateur discovery if at least one of them was an amateur. With these definitions, it appears that, on the average, two new comets out of every five have been amateur discoveries.

Figure 1 shows that – by chance – very few comets were being discovered around the time that the IAU was established and that – again by chance – almost all of them were amateur discoveries. Although the professional contribution then quickly increased, the rate of amateur discoveries remained steady into the 1930s, mainly due to the efforts of a number of observers in South Africa. Following a general decline during the mid-1930s, both amateur and professional activity picked up during World War II. Immediately after the war the professional searches at the Skalnate Pleso Observatory in Czechoslovakia and the discoveries made during professional sky surveys in California dominated the scene, with amateur finds then at a very low level; there were no amateur comets at all for 3.5 years beginning at the end of 1948. The extensive Japanese amateur discoveries of the 1960s narrowed the gap, and while continuing Japanese comets and discoveries by the Australian amateur Bradfield continued to make an impressive showing during the 1970s, there was also then unprecedented professional activity with large Schmidt telescopes in both hemispheres. This professional activity, supplemented by the results from the Infrared Astronomy Satellite, has again been evident during the 1980s, with the result that amateur comet hunters now find two or three comets were year and are responsible for about one discovery out of three.

During the interval under consideration there have been 15 amateur astronomers who have discovered (or co-discovered) three or more comets. These most successful hunters are listed by country in Table I. Curiously, these individuals represent only six different countries, the total contributions from which are also shown in the

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

Table I. Records for amateur discoveries of comets

Country	%	TOT	IND	
Japan	35	61	27	Honda 12, Seki 6, Ikeya 5, Fujikawa 5, Sato 4, Tago 3
U.S.A.	22	39	21	Peltier 10, Friend 3, Machholz 3
R.S.A.	13	23	9	Skjellerup 5, Reid 5, Forbes 4
Australia	10	17	6	Bradfield 12
U.K.	3	6	2	Alcock 5
Canada	2	4	1	Meier 4

The TOTal number of discoveries in each country represents a percentage % of the whole and is divided among the number of INDividual observers shown.

table. There are only two additional countries from which more than three amateur discoveries have been made – namely, New Zealand and the U.S.S.R., each with five discoveries. The discoverers of the remaining 14 comets were located in seven other countries.

It is sometimes very difficult to decide whether a particular astronomer is an amateur or a professional. Of course, several individuals clearly make their first contributions as amateurs and their later ones in professional positions on the staff of an observatory. For the purposes of this paper, students participating in professional programs have been counted as professionals, but former professional astronomers who have formally retired but who continue to work with their own equipment and no specific financial support are regarded as amateurs. When it comes to considering discoveries made by astronomers there is even more of a problem. Few professional astronomers have ever actually been paid to discover comets, but many amateurs have received financial rewards for doing so! Amateurs may tend to observe visually, make searches specifically for comets, usually relatively bright ones at quite small elongations from the sun; while professionals tend to observe photographically and may by accident pick up comets, usually faint ones in the general vicinity of opposition. This is far from a generalization, however. The professional program at Skalnate Pleso was entirely a visual one, and amateurs found two comets photographically in late 1986. That these should be the first amateur photographic discoveries in fourteen years may seem surprising when one considers that films with fuzzy blobs on them are submitted to the Central Bureau by hopeful amateurs a couple of times each month. A typical month will tend to yield a somewhat larger number of alleged visual discoveries that can generally be explained as ghost images of planets and bright stars or close configurations near the limit of the telescope of stars that are individually too faint to be recorded on the particular charts used by the observers.

Novae. Nova hunting is often coupled with comet hunting as a suitable activity for amateur astronomers, but until 20 years ago the only novae found by amateurs were ones that were conspicuous to the unaided eye. Since the IAU's beginnings about

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

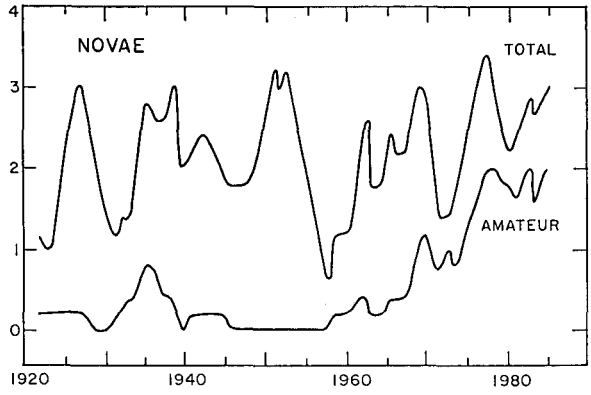

Fig. 2. The upper curve shows the total number of novae discovered per year, the lower curve the number found by amateurs. Values are smoothed over 5-year spans.

one nova in four has been discovered by an amateur. Annual rates, again smoothed over five years, are shown in Fig. 2.

Through the 1940s the occasional amateur discovery of a bright nova was of considerable interest to professional astrophysicists, but such finds represented a small fraction of the total novae found, as faint ones were noticed by professionals scanning patrol plates, often many years after the actual outbursts occurred. There were no bright novae between 1942 and 1960, and during the 1950s professional patrols effectively ground to a halt. Activity increased during the 1960s, and serious amateur searches got underway visually in the U.K. and photographically in Japan. For more than a decade there have been roughly two amateur nova discoveries and one professional nova discovery each year, although there is still always the possibility that photographic discoveries will surface years after the films were obtained.

Unlike comets, nova discoveries are normally credited to a single individual, and Table II shows the four amateurs who have made more than one discovery. The six remaining amateur discoveries are distributed among observers in five other countries. The first-discoverer rule is perhaps a little unfair. If it is relaxed, the U.S. would also be listed with two entries each for visual hunters Peltier and Collins.

Table II. Records for amateur discoveries of novae

Country	%	TOT	IND	
Japan	66	25	8	Honda 10, Kuwano 6, Wakuda 4
U.K.	18	7	4	Alcock 4

Visual nova hunting becomes very difficult when it approaches and exceeds the naked-eye limit, for it essentially requires the observer to commit to memory whole star fields in regions of the sky near the galactic equator. For reasons that are not

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

altogether clear amateur photographic hunting for novae has so far had no success whatsoever outside Japan. Perhaps more so than in the case of comet discoverers, the problem of distinguishing amateurs from professionals again exists. Liller and McNaught are classed as professionals, even though the four novae found by the former during the past four years in Chile and the two found by the latter during the past seven months in Australia clearly represent labors of love that define these astronomers as amateurs in the truest sense.

There is also a more troublesome problem involving nova discoveries. When a comet suspect is bright enough to be found by an amateur and is reported reasonably quickly, it is generally confirmed (or otherwise) as a real comet by its position and physical appearance and by its motion in the sky during the days following discovery. Confirmation of a nova is more difficult. Checks are routinely made at the Central Bureau as to whether a nova suspect is a known major or minor planet, possibly picked up confusingly near a stationary point, and limited checking of known or suspected variable stars is also possible. But a lot of unknown and unsuspected variables are relatively bright, particularly in the southern hemisphere, and definitive classification as a nova may require a fairly extensive spectroscopic study, perhaps coupled with the careful examination of many exposures made of the field since the beginning of the century. At least in the past, professionals have had to be brought in to do this, and even those who are particularly interested in eruptive variables are usually occupied with other work or lack the telescope time or plate libraries that are needed. Very few professionals are willing or able to make the effort necessary to establish whether even an object as bright as eighth magnitude is really a nova or not, particularly if the object is not brightening.

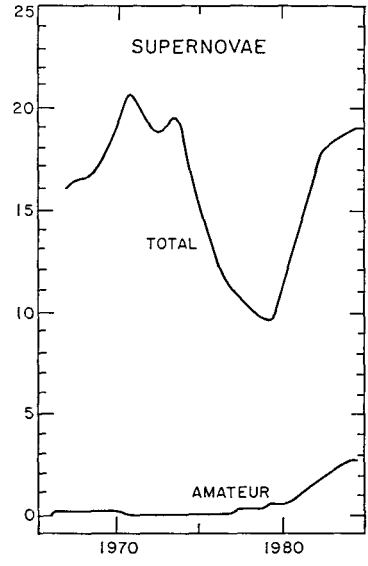

Fig. 3. The upper curve shows the total number of supernovae discovered per year, the lower curve the number found by amateurs. Values are smoothed over 5-year spans.

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

Supernovae. Although records of supernovae in other galaxies go back slightly more than a century, interest in them as phenomena distinct from ordinary novae dates back only half a century. The first amateur discovery of a supernova was by Bennett in South Africa in 1969, the second in Johnson in the U.S. in 1979. The smoothed totals in Fig. 3 show that professional discoveries had climbed to about 20 per year by the early 1970s, and the subsequent decline was due to the termination of the survey with the 1.2-m Schmidt at Palomar. Since 1980 there has been renewed interest and success by both professionals and amateurs. The annual total is back almost to the 1970 level, but with now some three discoveries per year by amateurs.
Amateurs who have found two or more supernovae are shown in Table III. The two Okazaki supernovae were also independently found by Evans. The truly remarkable contribution by Evans is entirely visual, while the Japanese discoveries are photographic. The single supernova 1987A in the LMC was independently found by the amateur Jones in New Zealand. Although supernova hunting has been widely discussed and indeed practised as an amateur activity in recent years, it is not as easy as the novice might think, and there are clearly many pitfalls for the unwary. As with visual nova hunting, the memory plays an important role in supernova hunting. Astigmatism can be a problem when galaxies are observed at different orientations in the sky. Comparison photographs of the galaxies to be scanned are generally useless, although there is some promise in the use of special drawings that attempt to depict the visual appearance of the galaxies. Photographic supernova searches require comparison with a library of earlier photographs of the same galaxies taken with the same telescope, emulsion, exposure time and sky conditions.

Table III. Records for amateur discoveries of supernovae

Country	%	TOT	IND	
Australia	68	15	1	Evans 15
Japan	18	4	2	Okazaki 2, Horiguchi 2

Minor planets. Although hunting for new minor planets enjoyed some popularity among amateur astronomers during the nineteenth century, and the U.S. amateur Metcalf and Austrian amateur Palisa were very active during the early part of the twentieth, there was a great hiatus in amateur discoveries between Palisa's last minor planet in 1924 and the Japanese amateur Urata's first in 1978. Although even the last of Palisa's 124 discoveries were visual, photographic patrols for these bodies had proven to be extremely efficient as soon as they were introduced in 1891, with several new discoveries possible on a single photographic plate. Just as amateurs were discouraged for several decades by professional successes in supernova hunting, so were they discouraged in the case of minor planets. From 1978 on, however, there has been a more-or-less steady increase in amateur activity (all photographic) with minor planets, and the rise from 2 in 1978 to 48 in 1986 is illustrated in Fig. 4. Unlike Figs. 1–3, Fig. 4 is on a logarithmic scale, and there has not been any smoothing. It should be noted that the numbers refer to the minor planets given provisional

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

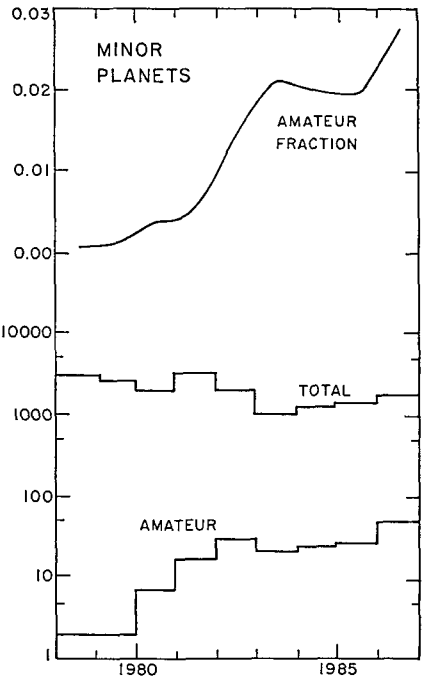

Fig. 4. The upper histogram shows (on a logarithmic scale) the total number of minor planets discovered per year, the lower histogram the number found by amateurs. The curve at the top shows the fraction discovered by amateurs.

designations, i.e., to the discovery or supposed discovery of an unidentifiable minor planet reported on the basis of the accurate measurement of the position of what may sometimes be only a single image. The fractional amateur contribution, rising from less than 0.001 to almost 0.03, is shown in the top part of Fig. 4. This fraction was actually as high as 0.075 (a total of 25 amateur discoveries) during the first third of 1987, although the fraction for the year will undoubtedly decrease in the future as professionals tend to be slower to process and submit their results than amateurs, and the prevailing weather patterns in the northern hemisphere mean that the largest professional minor-planet programs are most productive during the last third of each year.

Table IV shows all the amateur astronomers who have – from 1978 onward – discovered more than ten minor planets. All the amateur discoveries were made

Table IV. Records for amateur discoveries of minor planets

Country	%	TOT	IND	
Japan	81	160	11	Urata 85, Seki 62, Suzuki 40, Niijima 24, Furuta 11
Italy	19	37	3	Colombini et al. 26

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

in Japan or Italy, and the totals shown for the countries represent individual minor planets. The totals shown for the individuals involves some duplication, however, for the leading discoverer Urata works in colloboration with Suzuki, Niijima and several other amateurs not listed here.

Of the 197 amateur discoveries 25 are the principal discovery apparitions of numbered minor planets, 20 more are identified with numbered minor planets, and 45 are identified with unnumbered minor planets at other oppositions. Principal-apparition amateur discoverers of two or more numbered minor planets are shown in Table V, subject to the other qualifications noted in connection with Table IV. In addition, there are 42 discoveries for which preliminary orbits are available and 12 more observed on two different nights. What might be termed the "relative usefulness" of the amateur discoveries, whether measured in terms of the high fraction of principal-apparition discoveries of numbered minor planets (0.13) or the small fraction of discoveries observed on only a single night (0.26), is considerably greater than for professional discoveries.

Table V. Records for amateur principal-apparition discoveries of numbered minor planets

Country	%	TOT	IND	
Japan	92	23	8	Seki 11, Urata 9, Suzuki 3, Niijima 2, Furuta 2
Italy	8	2	1	Colombini et al. 2

Other Discoveries. Amateur discoveries in other areas of observational astronomy are understandably rather meager. Confirmed discoveries are generally restricted to occasional unusual variable stars found in the course of nova searches. Nova recurrences take place infrequently enough that, although it is in principle necessary for an observer only to monitor a few known points in the sky, the definite detection and intelligent announcement of an important outburst is unexpected enough that it effectively counts as a new discovery. Among the amateur contributors in this area Peltier in the U.S., Alcock in the U.K. and Jones in New Zealand are noteworthy. The occasional discovery of an unusual new feature on a major planet is in the same category, although the planets are probably better monitored nowadays by professional planetary patrols. Perhaps the most celebrated discovery of this type to be announced in the IAU Circulars was the white spot found on Saturn in 1933 by the British amateur astronomer and professional comedian Will Hay.

Recoveries of periodic comets as they return to perihelion have generally been the province of the professional astronomer armed with a large telescope and an accurate prediction. Predictions are sometimes significantly in error, however, particularly for a comet making its first predicted return or when the comet's motion is affected by large and irregular nongravitational forces. Since the IAU was established amateur astronomers have been involved with about one recovery in ten. Amateurs who have recovered or co-recovered more than one comet are shown in Table VI. There have also been three amateur recoveries in each of the U.K. and Australia (in the latter case all for the same comet) and one (by Jones) in New Zealand. Except

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

Table VI. Records for amateur recoverers of periodic comets

Country	%	TOT	IND	
Japan	52	15	4	Seki 12
U.S.A.	14	4	3	McClure 2
R.S.A.	10	3	2	Reid 2

for the faint comets recovered by Seki and McClure, almost all amateur recoveries have been visual. It has happened twice during the past three years that recoveries either were not made or could not be made until a comet was bright enough to be detected visually with a small telescope.

Follow-up Observations

Astrometry. Amateur astronomers are nowadays making an important contribution to the astrometric observations that follow a new discovery. Although highly desirable for new novae and supernovae, astrometry is of course essential if an orbit is to be calculated for a new comet or minor planet. A necessity during the first few days after a discovery, some astrometric coverage is useful as long as the comet or minor

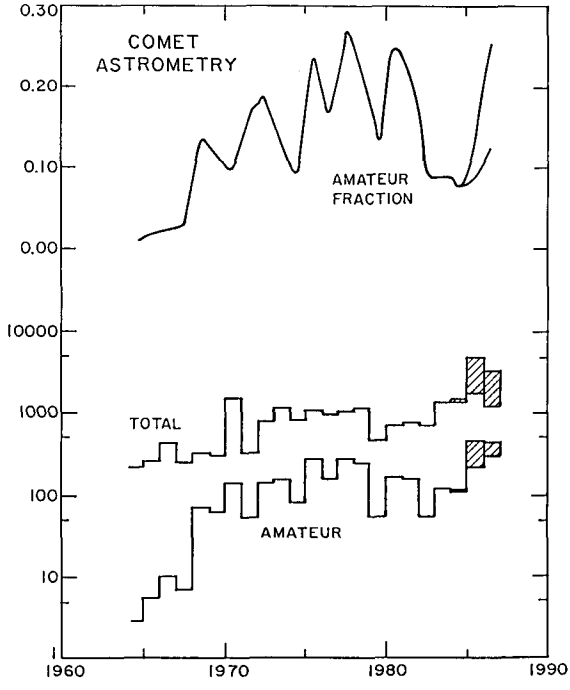

Fig. 5. The upper histogram shows (on a logarithmic scale) the total number of astrometric observations made of comets per year, the lower histogram the number made by amateurs. The shaded section refers to the observations of Halley's Comet. The curve at the top shows the fraction of observations made by amateurs, the upper and lower sections following the bifurcation being according as to whether Halley's Comet is excluded or included.

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

planet can be observed, particularly if there is some thought of recovering the object at subsequent apparitions.

Figure 5 illustrates the situation with regard to astrometric observations (essentially all photographic) of comets since 1964, the first year for which the machine-readable records of the Central Bureau/Minor Planet Center are essentially complete. As in Fig. 4, the scale in the lower section is logarithmic, and there has been no smoothing. The shaded section from 1984 onward refers to the observations only of Halley's Comet, to which the attention given has been completely out of proportion and largely useless. Up to 1967 the only amateur astrometric observations were a handful each year by Waterfield in the U.K. The top part of Fig. 5 shows that the fractional amateur contribution has averaged one out of seven but has been as high as one out of four. In the section from 1984 onward the upper curve is that when Halley's Comet is omitted, the lower curve that when it is included. Amateurs can take some consolation in the fact that the "band-waggon" effect of this well-publicized object was significantly less for them than it was in the case of the professionals.

Table VII lists the ten amateur observers who have made at least 100 cometary astrometric observations. In considering the Japanese results it should also be noted that Seki measured the films by Kojima, and Urata measured those by Suzuki and Furuta. The five countries tabulated are followed by France (with 89 observations), West Germany (80), the United States (50), and seven others (43 altogether).

Table VII. Records for amateur astrometric observations

Country	%	TOT	IND	
Japan	60	2168	39	Seki 973, Urata 232, Suzuki 158, Furuta 128, Kojima 122
U.K.	14	525	17	Manning 164, Waterfield 150
Australia	9	336	1	Herald 336
Italy	6	222	5	Colombini et al. 123
R.S.A.	3	100	1	Hers 100

In general, the accuracy of the cometary astrometric observations by amateurs compares very favorably with that of observations by professionals around 2 arcsec. An observation by an amateur is about equally likely as that by a professional to be affected by some gross error, more often than not one of exactly an hour or exactly a day in the indicated time of mid-exposure. The speed with which amateurs reduce and report their data is generally rather greater than that of professionals.

The statistics for astrometric observations of minor planets are not illustrated here. Several of the comet observers (though not those in the U.K. or R.S.A.) also routinely make observations of unnumbered minor planets, and if observations of the brighter numbered minor planets are also included, the contribution from several observers in West Germany and one observer in East Germany can be noted. While the accuracy of amateur minor-planet astrometry is comparable to that of amateur cometary astrometry, the best professional data are internally consistent to better than 1 arcsec. This is particularly true of CCD data, and with the anticipated improvements

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

in reference-star positions much of the absolute professional astrometry will be noticeably more accurate than the amateur data.

Photometry. By far the most pervasive contribution by amateur astronomers to the IAU Circulars nowadays concerns photometric data on comets and novae, and occasionally also on other unusual variables, notably information on the fadings of variables of R CrB type. Although some of the non-cometary observations are obtained photoelectrically, most of them consist of comparisons by eye with reference stars nearby. The visual magnitude estimates that are published are only a tiny fraction of all that are coordinated, made and eventually collected by organizations of variable-star observers in several different countries, and the following speaker will discuss such observations in detail.

The cometary magnitude estimates published are also only a small fraction of such data handled by similar national groups, as well as by the International Comet Quarterly and the amateur net of the International Halley Watch, the latter to be discussed by another speaker. The comet magnitudes refer to the total coma and are sometimes accompanied by estimates of coma size, tail length and other physical characteristics of the comet. The selection of amateur photometric data published on the IAU Circulars is intended to be as current as possible, so that professional observers can appropriately plan their own work.

Orbit Computations

Although some may consider that the incorporation of remarks on orbit computations by amateurs is inappropriate in a part of this Colloquium dealing with observations, such computations are intimately involved with astrometric observations and in some sense are only a minor extension of them. The computations range from that of a very preliminary orbit of a new comet or minor planet, through successive improvements of the orbit, to the point where it is necessary to consider the effects of planetary perturbations and to make predictions for future potential apparitions. Computations for comets might involve some allowance for non-gravitational effects, and those on minor planets a search for past identifications of the same object. Complementing their involvement with astrometric observations directly, several amateur astronomers are nowadays doing fine work in all these areas, and it is being published by the Minor Planet Center.

The British Astronomical Association has the longest tradition for such work, dating back to the 1920s, particularly with respect to predictions for the returns of comets, although preliminary orbits were also sometimes calculated. This author started out as an amateur involved with such work in those far-off days of logarithms and mechanical calculating machines. In Japan and in West Germany the amateur computations 30 or 40 years years ago were more likely to involve minor planets, and a good many preliminary elliptical and circular orbits were produced. One of the Japanese orbit computers of that time was the great observer Seki, while his countryman Hasegawa, who will be speaking later in this session, was making many computations of preliminary orbits of comets. One of the German amateurs, Kippes,

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

embarked on the subject of minor-planet identification, work that is in practice more difficult because of the need to organize databases of both astrometric observations and preliminary orbits. Kippes did this work by hand, as he still does four decades later.

For many amateurs, however, the availability of modern microcomputers has revolutionized orbit-computational work, just as main-frame computers (as well as microcomputers) have done so for professionals. The amateurs in the British Astronomical Association, notably Milbourn, who has also done his share of hand computation, continue to work on comet orbits, and German (Landgraf, Kretlow) computations on minor-planet orbits and identifications have been supplemented by those from amateurs in Belgium (Goffin) and Canada (Lowe). But the greatest and most impressive activity is by the Japanese amateurs, who tackle minor-planet and comet orbits with equal facility, several of them utilizing and exploring new techniques for finding minor-planet identifications (Nakano, Kobayashi, Urata, Furuta, Oishi) and solving for cometary nongravitational parameters (Nakano, Kobayashi).

Concluding Remarks

The most obvious conclusion that can be drawn from this paper is that Japanese amateur astronomers are collectively the best in the world and that they completely dominate in all the areas considered except that of the discovery of supernovae, where they defer to Australia. In addition to its lone supernova discoverer Australia's general very high standing is due also to one outstanding comet hunter and one extremely productive amateur astrometrist. Amateurs in the United Kingdom make a very strong showing in astrometry, and – thanks basically to one individual – also in visual nova and to a lesser extent comet hunting. The only other countries showing good collective effort in multiple areas are the United States and South Africa. There are some contributions from France, West Germany, Italy, Belgium and New Zealand but relatively little from Second World countries and none from countries of the Third and Fourth Worlds.

The intense Japanese and British contributions to observational astronomy are curious because these countries are both notorious for their cloudy skies. The other three leading countries are of course geographically larger and more blessed with good weather, but the United States also has a considerably larger population, and for that reason one must say that its total contribution is disappointingly small. Part of this is undoubtedly because U.S. amateurs tend to shun anything that may involve anything mathematical (in spite of the widespread availability of modern microcomputers); all 50 astrometric positions of comets (as well as all the positions of minor planets) were made by one largely unknown amateur, Terry Handley of Burlington, New Jersey; and the only orbital work has been the suggestion of a number of minor-planet identifications by another relative unknown, Frank Bowman of Cincinnati, Ohio.

Tsutomu Seki of Kochi, Japan, emerges quite definitely as the leading all-round amateur astronomer in the world, his astounding productivity ranging from

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press

the visual discovery of comets to photographic astrometry (including comet recovery) and occasional orbit computations. Honda and Alcock, and to a lesser extent Peltier, Reid and Jones, appear as outstanding observers involving both comets and novae. Urata, and to a lesser extent Furuta, contribute to both astrometric observations and minor-planet orbit computations and identifications. Essentially all the amateur contributions to the Central Bureau/Minor Planet Center have been made by fewer than a hundred individuals, not one of whom is female.

What of the future? The straightforward answer is "More of the same", and to a large extent this will undoubtedly be true. Professionals have talked about making automated surveys, particularly for supernovae, using devices involving scanning CCDs, but the productivity to date has not exactly been impressive. A few rugged individualist amateurs bounced back from the threat of the photographic plate, and they will do the same in the case of the CCD. And just as some amateurs joined the professionals and have undertaken photographic survey work of their own, others can in the future be expected successfully to exploit the use of the CCD. Visual comet hunters still rule the productive twilit skies near the sun, but one suspects that other hunting techniques, in the hands of both amateurs and professionals, are likely to encroach upon this territory in the future.

Discoverers are going to have to be aware that amateur astronomers will need to play a greater role in obtaining follow-up observations. Amateur astrometrists are already performing well in getting positions of new comets, but as professionals do less and less of this important work the burden on amateurs will have to increase. The nova situation is even more serious, for if hunters are going to continue to produce nova suspects that are well below naked-eye visibility, it will become necessary for amateur spectroscopists, not only to obtain good-quality spectra of the suspects, but also correctly to interpret these spectra. This is probably in fact the single most important problem for observational amateur astronomers to address in the immediate future.

https://doi.org/10.1017/S0252921100092253 Published online by Cambridge University Press