A new method for visual meteor observations

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We present an easy to construct piece of equipment that can be of help to identify positions on the celestial hemisphere and which is useful for meteor observations. We describe the design and, verification tests and first results.

1 Introduction

1.1 The 'astronomical pick'

Astronomical observations are carried out, as a rule, at night when it is dark. For naked eye observations stars have to be used for identifying the field of view and celestial position of meteors. This not an easy task. To make naked eye astrometry easier, the 'astronomical pick' (Fig. 1) could be used. It represents a small framework consisting of several parallel rods. On the ends of the rods nails are hammered which stick a few millimeters out. It is essential that the distances between successive nails are strictly identical, in other words, the straight lines a, b and c in Fig. 1 are parallel. The 'astronomical pick' is mounted on a mobile support.

Basically a single rod is sufficient for one observer. The construction of server Al parallel rods has the advantage that more observers can use the same device and only one assistant is needed to read the dials.

1.2 How to use the device

- Level the device in the horizontal plane by means of two levels, which are placed on it, and four adjustment screws.
- Point the the device to the celestial pole and write down azimuth and height (A_0, h_0). This data is needed for calibration of the coordinates.
- Start meteor observing.
- When a meteor is noticed the observer informs immediately the secretary about the event in order to let him write down the time of appearance. Then, while keeping the eyes fixed on the same location on the sky and visually having remembered the path of the meteor, he guides the 'astronomical pick' to the begin point of the meteor and then on to the end point. For increase of

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the accuracy an extra intermediate third point on the trajectory can be taken too. It is preferable that an assitent reads the azimuth and height circle (A_b, h_b, A_e, h_e) for improvement of the accuracy. In the case a meteor is noticed by several persons, the most skilled one should use the 'atmospheric pick'.

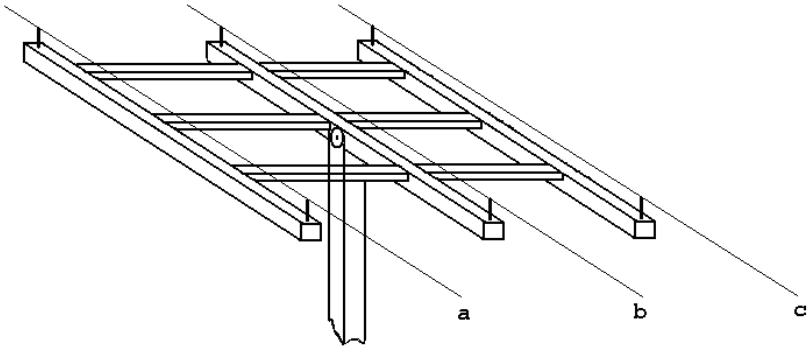

Figure 1 – A classical type 'astronomical pick'.

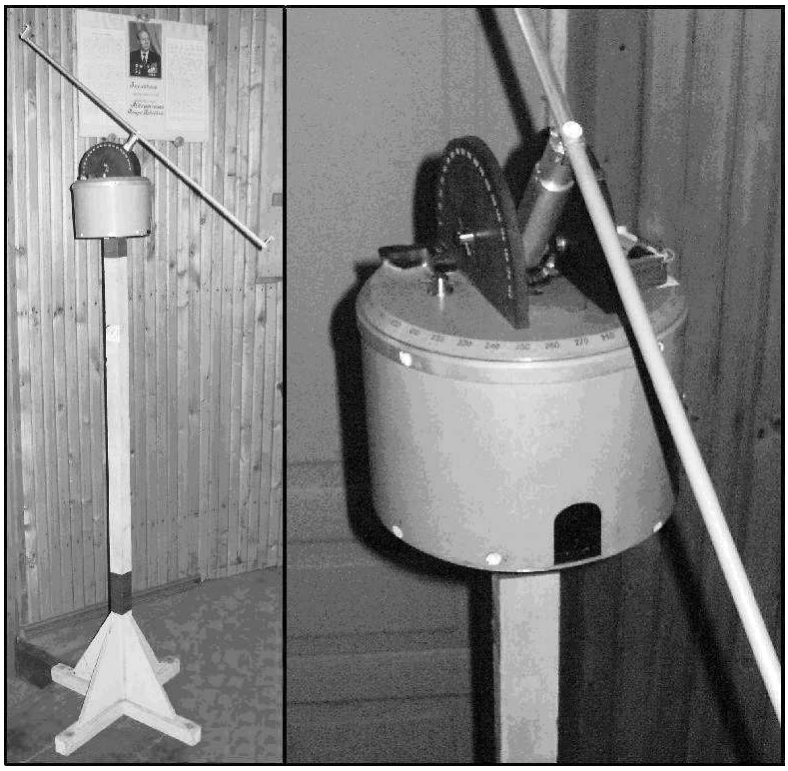

Figure 2 – 'Astronomical pick', made a grammar school.

Certainly, the complexity of this method is the keeping in mind of the path of the meteor. It obviously is the biggest error source. Therefore the obtained accuracy of the method depends mainly on the skills and experience of the observer.

1.3 Reduction

For processing the positional data (i.e. converting from azimuth, height to right ascension, declination, we need to know the geographical latitude of the location of observations ϕ and the sidereal time s at the moment the meteor appeared. We calculate the equatorial coordinates α and δ using the following formulae: For declination:

$$\sin\delta = \sin\phi \cdot \sin h + \cos\phi \cdot \cos h \cdot \cos A \tag{1}$$

and for a hour angle:

$$\tan t = \frac{\sin A}{\cos\phi \cdot \tan h + \sin\phi \cdot \cos A} \tag{2}$$

The relation between hour angle t, sidereal time s and right ascension α is:

$$\alpha = s - t \tag{3}$$

The returned value of equation (2) has to be checked for its sign. It is necessary to add 180° if the denominator of the above-stated formula is negative. When the denominator is positive and the extracted corner is negative, 360° has to be added.

2 Measurements

We have written a computer program 'ma4' for processing the data, which includes the calibration in the beginning as well. On March 30/31, 2005 we have done measurements of equatorial coordinates of some stars and have compared 'ma4' results with the planetarium software COSMOS. Results are given in Table 1.

Table 1 – Measured and calculated coordinates of several objects in the sky.

Object, t (UT+3h)	Observation				ma4		COSMOS	
	Ax	hx	A	h	α	δ	α	δ
Arctur, 22:14:06	53.5°	118°	93.5°	28.0°	$14^h24^m45^s$	19°07′39″	$14^h15^m55^s$	19°09′33″
Regul, 22:15:27	131.5°	142°	171.5°	52.0°	$10^h12^m01^s$	33°15′50″	$10^h08^m39^s$	11°56′27″
Regul, 01:49:20	203°	126°	243°	36°	$10^h14^m32^s$	31°37′25″	$10^h08^m39^s$	11°56′27″
Vega, 01:51:00	29.5°	124.5°	69.5°	34.5°	$18^h46^m10^s$	38°21′13″	$18^h37^m07^s$	38°47′17″
Arctur, 05:10:12	198°	138°	238°	48°	$14^h17^m33^s$	20°19′05″	$14^h15^m55^s$	19°09′33″
Moon, 05:12:30	137.5°	103°	177.5°	13°	$16^h59^m41^s$	−26°30′43″	$16^h53^m14^s$	−27°42′31″

From the measurements of the coordinates of stars we concluded that the 'astronomical pick' gives an error of approximately ±1.5°. For meteor observations the error without the device is in the order of 10°, hence this is a huge improvement. Moreover, the 'astronomical pick' technique can probably be improved more.

3 Observation of background meteor activity on March 30/31, 2005

As already mentioned in the previous section we tested the 'astronomical pick' in the night March 30/31, 2005 in the city of Kiev, on an athletic field of our grammar school. Observations took place in shifts: two groups of 3 men. For 6 hours (from 23:00 onwards) only 12 meteors were observed. Their paths were plotted on celestial maps, represented in Figures 3, 4. In Figure 3 (gnomonic projection) black lines represent meteors seen in 2004; red lines meteors in 2005. In Figure 4 we used the celestial map from planetarium STARCALC. Here, strictly spoken, the meteor trails should not be straight lines but arches due to the chosen projection of the map, hence we can only trust the begin- and end points.

Three meteors (No. 3, 5, 6), most likely, belong to a radiant. Meteors No. 8, 11, when we take the error into account can also belong to it. The found radiant position at $\alpha = 211°$, $\delta = +15°$ is a little bit different from the one found in 2004's data which is at $\alpha = 215°$, $\delta = +13°$). It can be explained by daily shift, and also by errors in the observations. Possibly the activity is caused by the small shower March Bootids which is known from domestic catalogues (period of activity: all the March long; maximum: March 10 and 18; radiant 220°, +10°). In foreign catalogues and the IMO catalogue this stream most likely corresponds to the ζ-Bootes DBO (period of activity: March 5-15; maximum: March 1; radiant 218°, +12°). Our estimate of the angular velocity of the seen meteors of the stream is in line with the data of domestic catalogues which lists 45 km/s.

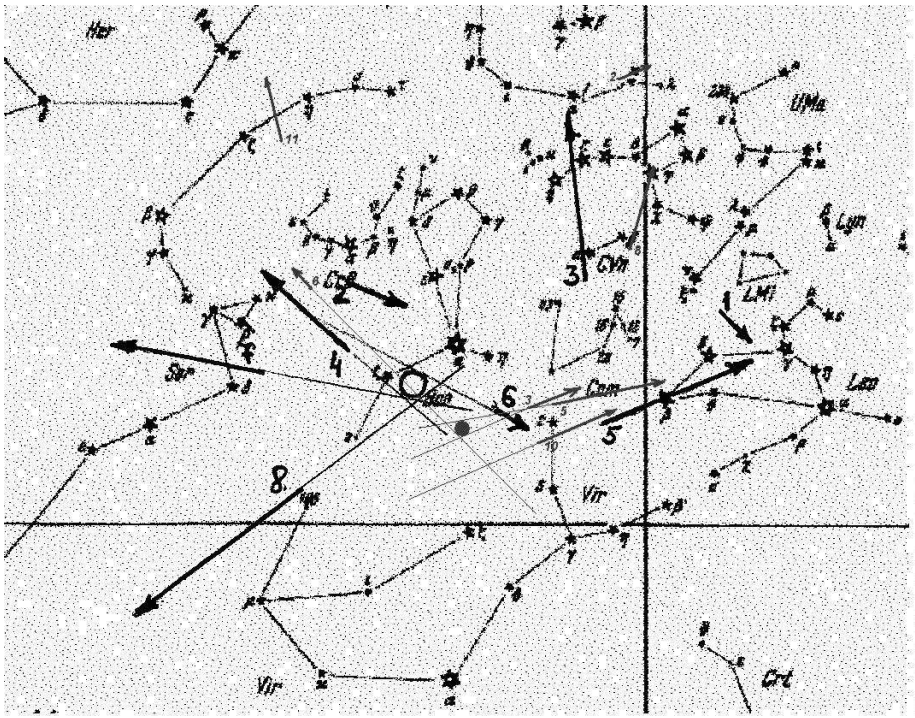

Figure 3 – Map of the night sky in gnomonic projection with plotted meteors, observed on March 30/31, 2005 and March 31/ April 1, 2004

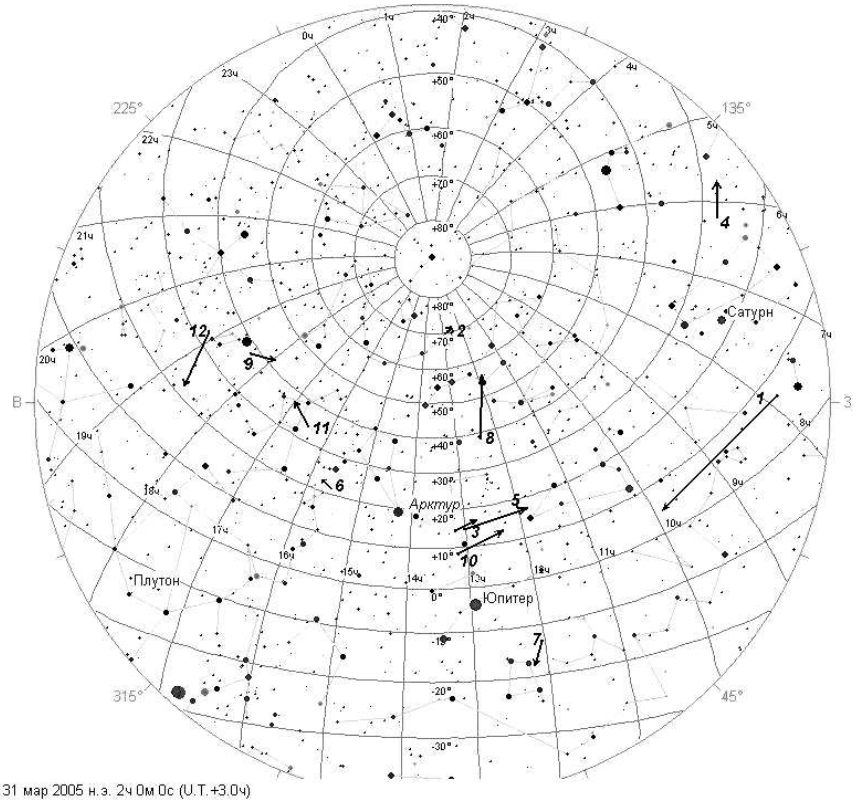

Figure 4 – Map of the night sky from planetarium software STARCALC, with plotted meteors, observed on March 30/31, 2005 and March 31/ April 1, 2004

4 Conclusion

- We developed and manufactured an original device by means of which it is possible to determine horizontal coordinates of a point on the celestial sphere with an accuracy 0.5°.
- We developed and created a technique which is useful for monitoring weak meteor streams where plotting of meteors on a map in gnomonic projection is important.

- We developed computer program to do the coordinate transformation.
- A test of the 'astronomical pick' with measurements on stars, has been done which gave errors of $\pm 1.5°$.
- First results obtained with the 'astronomical pick' on March 30/31, 2005 showed presence of the March Bootes with a radiant at $\alpha = 211°$, $\delta = +15°$ (tabulated value: $\alpha = 220°$, $\delta = +10°$).

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View at the computer corner: Vladimir Sliusarenko among others reading his E-mail (photo Dragana Okolić).