THE INFLUENCE OF ATMOSPHERIC ABSORPTION ON VISIBILITY OF GALAXIES

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ABCTRACT. We discuss the influence of atmospheric extinction to visibility of galaxies in the visual region of the spectrum. For this purpose the plates covering the same, small region of the sky taken with 2-m telescope, at different zenith distances were obtained. We investigated the relation between galaxy counts and the zenith distance. We show that the influence of the atmospheric mass to the visibility of galaxies is the same as for stars.

Key words: atmospheric absorption; teaching of astronomy.

1. Introduction

The quality of astronomical observations strongly depends on conditions of the Earth atmosphere. There are several factors influencing the accuracy of observations. The atmospheric refraction lowers the accuracy of astrometry; atmospheric absorption causes significant errors in photometric and spectrophotometric measurements, different for point-like images, i.e. stars, and extended objects such as nebulae and galaxies.

For stars at zenith distances $z < 30^\circ$ secans law describing the atmospheric mass works well. The zenith distance is the distance of an object from the zenith of a observer, equal to 90° minus altitude of an object. For greater zenith distances the formula with higher powers of the series expansion of the $\sec z$ is applied (Goley, 1974; Walker, 1987).

For galaxies the atmospheric influence is not the same for inner and outer parts of a galaxy. The counts of galaxies can be seriously biased by selection effects, mainly due to the brightness of the night sky (Disney, 1976). It is even possible that dim external regions of galaxies can be invisible, causing that galaxy can appear as star. Such phenomenon obviously changes galaxy counts. The photometry of galaxies has a number of features and interpretations directly or indirectly concern numerous questions of physics of galaxies. Effect of seeing and its influence on galaxy photometry has been carefully studied by Saglia et al. (1993). It is interesting to point out that the first results of the correlation function based on Lick counts (Shane & Virtanen, 1967) as presented by Groth & Peebles (1977) led to the discussion on the factors influencing galaxy counts (Geller et al., 1984, Groth & Peebles, 1986a, 1986b; de Lapperent et al., 1986; Brown & Groth, 1989).

In order to check the influence of atmospheric mass to galaxy counts we obtained the adequate data and we investigate the relationship between the number of galaxies seen on the plate and the zenith distance.

2. Observational data

The direct photographs of the one square degree of the sky were taken using the two-meter telescope of the Rozhen National Observatory (Bulgaria).

The involved photographic material consists of 30×30 cm plates ORWO ZU-21, in the photometric system close to IP_v obtained at 6 different zenith distances. Plates were developed in standard manner. All plates were taken during one non-photometric night, but with stable seeing. The centre of each negative has coordinates $\alpha = 11^h 21^m 07^s$ $\delta = 35°07'30''$. We have accepted the middle time of exposure as observation time and the zenith distance was calculated for this moment. The counts of galaxies were performed using light table and a small magnifier. The used magnifications were $6^\times$ and $10^\times$.

3. The results and discussion

We performed galaxy counts independently on each plate. Results are presented in Table 1. Co1umns 1 and 2 give results of galaxy counts made by the same observer, without and with magnifier accordingly. In columns 3–7 counts of other observers are presented and in column 8 the mean of counts is given.

We found the dependence of galaxy number on the zenith distance. Two different variants of the representation of the relation are shown in Fig.1*a* and *b*.

Correlation coefficient in both cases is equal 0.99. So, we found a very good correlation among galaxy counts and the zenith distance. The relation among investigated parameters can be expressed as:

$$N = a + b \cos z + c \cos^2 z \text{ or } N = a/(b + c \sec z)$$

It is clear that the atmosphere mass drastically diminishes the number of seen galaxies. The optical thickness of the atmosphere decreases with the zenith distance, so the faint external parts of galaxies are disappearing, causing the indistinguishability galaxies and stars. We show that the atmosphere mass diminishes the number of galaxies in the same manner as stars.

4. Conclusions or methodical remarks

The presented considerations allow us to prepare a special exercise for student and pupils. Because we have in our disposal photographic plates it was very easy to built a light table. The magnification glass is also not a problem. It is not very difficult to obtain photographic material even using own equipment, because this exercise does not need data from 2-m telescope. Smaller aperture can be also useful. From the methodical point of view this laboratory exercise allows pupils and students to have contact with a part of real astronomical work. Moreover, the look to objects registered on the plate permit one to have filling of the enormous number of shapes of astronomical objects.

Even such simple procedure as counts of objects leads to discovery of the law describing the influence of the atmosphere to the visibility of objects. In practical manner such exercise shows the influence of dark sky to the visibility of galaxies and well known conclusion why astronomers prefer clear, moonless nights, without bright background and observed object at small zenith distances. Therefore, it can be very instructive for students why we should preserve the darkness of the night sky and to exhibit great efforts to keep the night sky clear for the next generations.

Of course the present day astronomy is using plates rather rarely, preferring modern electronic devices, like e.g. CCD. Nevertheless, the problems occurring in this exercise are not easy solvable when the modern devices are in use too. Moreover, the acquaintance with so great variety of extended structures in astronomy gives students the filling how complicated are the problems with pattern recognition, and how difficult is to construct programmes teaching computer how to separate and classified images of different structures. Students will be well informed on the high complexity of such problems also when possible solution is based on neural networking.

References

Brown, M.E., Groth, E.J.: 1989, *ApJ*, **338**, 605.
Disney, M.J.: 1976, *Nature*, **263**, 573.
Geller, M.J., De Lapperent, V., Kurtz, M.J.: 1984, *ApJ*, **287**, L55.
Goley, M.: 1974, "Introduction to Astronomical Photometry", D. Reidel Publ. Co., Dordrecht.
Groth, E.J., Peebles, P.J.E.: 1986a, *ApJ*, **310**, 499.
Groth, E.J., Peebles, P.J.E.: 1986b, *ApJ*, **310**, 507.
Groth, E.J., Peebles, P.J.E.: 1977, *ApJ* **217**, 385.
de Lapperent, V., Kurtz, M.J., Geller, M.J.: 1986, *ApJ*, **304**, 505.
Saglia, R.P., Bertschinger, E., Baggley, G. et al.: 1993, *MNRAS*, **264**, 961.
Shane, C.D., Wirtanen , C.A.: 1967, *Publ. Lick Obs., Vol. XXII*, part 1.
Walker, G.: 1987, "Astronomical Observations, an optical perspective", Cambridge Univ. Press, Cambridge.

Table 1: The number of galaxies for individual plates.

z°	Galaxy counts							
	1	2	3	4	5	6	7	8
64	457	567	432	444	416	449	429	456
55	801	904	667	659	672	663	675	720
45	1067	1214	1005	1011	1066	1097	1076	1077
36	1385	1582	1381	1478	1421	1392	1371	1430
28	1697	1777	1741	1728	1732	1738	1746	1737
21	1999	2199	2118	2126	2123	2135	2114	2116

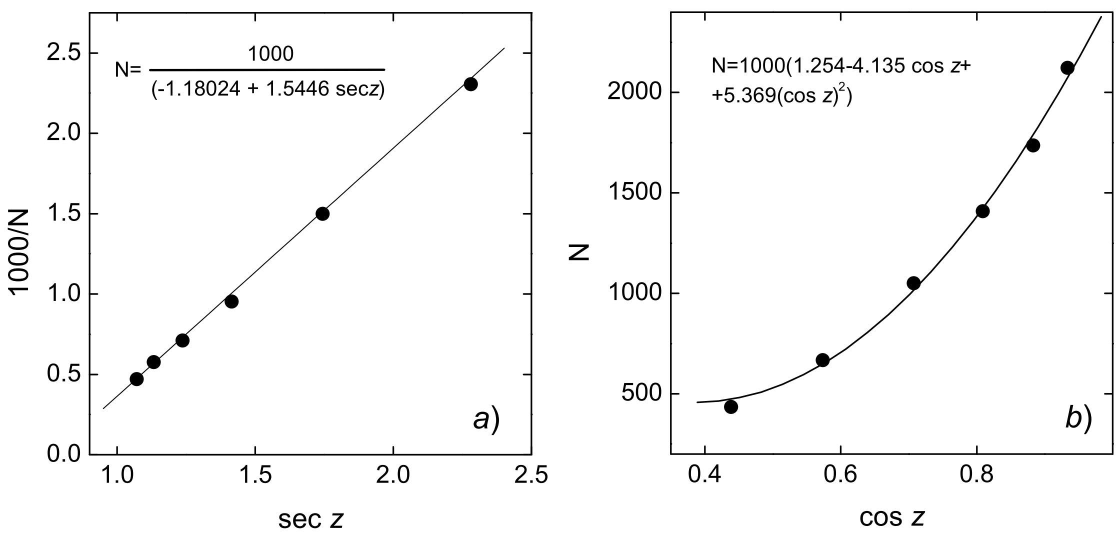

Figure 1: Dependence of galaxy numbers on $\cos z$ (a) and $\sec z$ (b).