Utilization of MASH Planetary Nebula Catalogue of the Year 2006 for the Determination of the Milky-Way Plane

A.M. Sendi

M.Sc. Student, Astronomy and Space Science,
Faculty of Science, King Abdulaziz University,
Jeddah, Saudi Arabia

Abstract. In this paper, the equatorial coordinates of the galactic pole (α_p, δ_p) for the epoch 2000.0. was computed using the most recent data of the MASH planetary nebulae catalogue of the year 2006. As a result, the inclination of the Milky way plane to the celestial equator i_g and the right ascension of its ascending node Ω_g at the same epoch are also computed.

Keywords: Position astronomy, Galactic structure**,** ephemeris.

1. Introduction

In many applications of position astronomy and galactic structure, *e.g.*[1], the determination of the orientation of the Milky way plane's to equatorial plane at certain epoch is of extreme importance, not only to coordinate transformations, but also for some problems concerning the relation between the astrophysical properties of celestial objects with their condensation towards a plane, the Milky way (*e.g.* the Milky way condensation of young Population I objects). Recently, a general analytical method was developed[2], [hereafter will be referred to as Paper I] for the determination of any celestial plane orientation of objects with respect to fundamental plane at certain epoch.

In the present paper, this method is applied for the determination of: 1. the equatorial coordinates of the galactic pole (α_p, δ_p) for the epoch 2000.0. 2. The inclination of the Milky way plane's to the celestial

equator i_g and the right ascension of its ascending node Ω_g at the same epoch. The input data of this application is MASH planetary nebulae catalogue (Macquarie / AAO / Strasbourg Halpha Planetary Nebula Catalogue) of the year 2006[3]. In this catalogue over 900 true, likely and possible new Galactic planetary nebulae (PNe) are listed.

2. Formulations

According to Paper I, the galactic constants $(\alpha_p, \delta_p, i_g, \Omega_g)$ for the epoch 2000.0 could be determined from:

$$\delta_p = \sin^{-1}(n)\,, \ \alpha_p = \tan^{-1}(\frac{m}{\ell})\,, \ i_g = 90^\circ - \delta_p \ \text{and} \ \ \Omega_g = 90^\circ + \alpha_p$$

where (λ, ℓ, m, n) are the global minimum of the function:

$$F(\ell, m, n, \lambda) = \mathbf{L}^T \mathbf{A} \mathbf{L} - \lambda(\mathbf{L}^T \mathbf{L} - 1)\,,$$

$\mathbf{L} \equiv (\ell, m, n)$ and λ are respectively the eigen vectors and the eigen values of the symmetric matrix $\mathbf{A}_{3\times3}[a_{ij}]$:

$$a_{11} = \sum_{i=1}^{N} x_i^2 \ ; \ a_{12} = \sum_{i=1}^{N} x_i y_i \ ; \ a_{13} = \sum_{i=1}^{N} x_i z_i \ ; \ a_{22} = \sum_{i=1}^{N} y_i^2 \ ;$$

$$a_{23} = \sum_{i=1}^{N} y_i z_i \ ; \ a_{33} = \sum_{i=1}^{N} z_i^2\,.$$

The coordinates (x_i, y_i, z_i); $i = 1, 2, \cdots, N$ of the N selected PNe at unit distance from the sun are:

$$x_i = \cos\delta_i \, \cos\alpha_i \quad ; \quad y_i = \cos\delta_i \, \sin\alpha_i \quad ; \quad z_i = \sin\delta_i$$

where (α_i, δ_i) are the equatorial coordinates of the nebulae for the epoch 2000.0.

3. Applications

3.1. *Data*

The equatorial coordinates of PNe for the epoch 2000.0 are taken from Hipparcos main catalogue whose table number at CDS (Strasbourg astronomical data center), is: V/127 MASH catalogue planetary nebulae[3] .

3.2. *Numerical Results*

The results $(\alpha_p, \delta_p, i_g, \Omega_g)$ for the epoch 2000.0 are given below. Each of these results is the average of five values corresponding to galactic latitudes $b = 1^o$, 2°, 3°, 4°, 5°.

$$\alpha_p = 192.833^o \;\; : \;\; \delta_p = 26.9014^o \;\; ; \;\; i_g = 63.0986^o \;\; ; \;\; \Omega_g = 282.833^o$$

In concluding this paper, general analytical method[2] for the determination of any celestial plane orientation of objects with respect to fundamental plane at certain epoch was applied for the determination of: 1. the equatorial coordinates of the galactic pole (α_p, δ_p) for the epoch 2000.0. 2. The inclination of the Milky way plane to the celestial equator i_g and the right ascension of its ascending node Ω_g at the same epoch. The input data of this application is MASH planetary nebulae catalogue of the year 2006[3].

References

[1] **Meeus, J.,** *Astronomical Alogorithms*, Willmann-Bell, Inc. (1991).
[2] **Sharaf, M.A.,** *Journal of Romanian Astronomical Journal* (to appear) (2007).
[3] **Parker, Q.A., Acker, A., Frew, D.J., Hartley, M., Peyaud, A.E.J., Phillipps, S., Russeil D., Beaulieu, S.F., Cohen, M., Koppen, J., Marcout, J., Miszalski, B., Morgan, D.H., Morris, R.A.H., Ochsenbein, F., Pierce, M.J.** and **Vaughan, A.E.,** *Mon. Not. R. Astrono. Soc.*, **373**(1): 79-94 (2006).

استخدام كتالوج MASH للسدم الكوكبية لعام ٢٠٠٦م لتعيين مستوى الطريق اللبني

أحلام محمد سندي

طالبة ماجستير – فلك وعلوم فضاء

كلية العلوم– جامعة الملك عبدالعزيز – جدة– المملكة العربية السعودية

المستخلص. تم في هذه البحث تطويع طريقة تحليلية عامة لتعيين الإحداثيات الاستوائية لقطب المجرة للحقبة 2000.0 وأيضًا تعيين ميل الطريق اللبني على الاستواء السماوي، وطول عقدة الصعود له لنفس الحقبة. استخدم لهذه الحسابات أحدث بيانات للسدم الكوكبية المنشورة في كتالوج MASH 2006.