APPLICATION OF THE TITIUS-BODE LAW IN EARTHQUAKE STUDY

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ABSTRACT. This article introduces application of the commensurability revealed by Titius-Bode Law in earthquake (EQ) prediction study. The results show that occurrence of the most of the world's major earthquakes is not accidental, and they occurred at the commensurable points of time axis. As an example, both EQ 7.0 in Lushan, China on 2013–04–20 and EQ 8.2 in Iquique, Chile on 2014–04–01 occurred at their commensurable epochs. This provides an important scientific basis for the prediction of major EQ, which will occur in the area in future.

1. INTRODUCTION

In the ITRF model, station motion is described by the piecewise linear model. However, the actual station motion is more complicated and includes other effects such as seasonal and irregular position variations as well as jumps and exponential relaxation after large earthquake (EQ). So, the studies on the EQs time distribution and prediction is of large importance for the assessment of the ITRF stability.

During recent years huge EQs frequently occurred and made surprise attacks on many places of the globe, especially in the south and east of Asian, and the seismic belt around the Pacific Ocean. Since the EQ 9.0 occurred in Sumatra in 2004, then the EQ 8.0 in Chile in 2010, the EQ 9.0 in Honshu in 2011, the EQ 8.2 in Chile in 2014, etc. They caused strong impact to the expecting continued developing economy and the tranquility of human society of the world. Frequent exceptional strong disasters of EQs remind that we must strengthen our research on cause of formation, mechanism, prediction and forecast of the EQs, and achieve the goal of advancing the development of Earth science and mitigation of seismic disasters.

We have therefore in-depth studied the commensurability revealed by Titius-Bode law. Based on many years' research and development of Titius-Bode law, we compiled a FORTRAN program, which we used to analyze major EQs in the world since 1900. We found that most of the world's major earthquake occurred at their commensurable points of time axis (Hu et al., 2013). Both EQ 7.0 in Lushan, China on 2013–04–20 and EQ 8.2 in Iquique, Chile on 2014–04–01 occurred at their commensurable points of time axis. This once again proves the universality of the commensurability.

2. TITIUS-BODE LAW AND ITS EXPANSION

Titius-Bode law in its classical formulation has the following form:

$$a_n = 0.4 + 0.32 \times 2^{n-2} \,, \tag{1}$$

which can be also expressed as

$$\beta = \frac{a_{n+1}}{a_n} \,, \tag{2}$$

where a_n is the distance of the planet n from to the Sun in astronomical units, n is the order number of the planet, and β is the commensurable value for the planets in the solar system (Zhang et al. 1980).

Weng Wenbo (Weng, 1981) pointed out that the commensurability is one of the orders in the natural world. The equation (2) brings light to the distribution law of the matter in a space region, and for time domain the commensurability can be expressed as (Weng, 1981)

$$\Delta X = \frac{X_{i+\Delta i} - X_i}{K} \ , \tag{3}$$

where K is an integer constant. If the above relation is tenable, then the data set $\{X_i\}$ is commensurable. ΔX is the commensurable value of the data set $\{X_i\}$, and $X_i, X_{i+\Delta i} \in \{X_i\}$. The subscript Δi is the difference between the sequential numbers of the two arbitrary data in the data set $\{X_i\}$. In our practical analysis and computation $\Delta i \equiv 1$ (Weng, 1981).

3. PREDICTION ON THE LUSHAN EQ 7.0 IN CHINA OF 2013 AND THE IQUIQUE EQ 8.2 IN CHILE OF 2014

An EQ 7.0 occurred in Lushan, China on 2013–04–20. We point out that the expanding time points in its time axis are the time point when a future EQs may occur (Hu et al.,2013). In the paper we analyzed the commensurability of the EQs in the Sichuan–Yunnan region since 1900.0 and obtained its commensurable value to be 2.44 years. The previous EQ of M≥7.0 is the Wenchuan EQ 8.0 occurred on 2008–05–12, i.e. 2008.36, so

$$2013{-}04{-}20 = 2008.36 + 2.44 \times 2 = 2013.31 = 2013{-}03{-}29 + 22 \text{ days} \ .$$

It occurred just at the commensurable point equal to two times of its time axis. Its absolute error is 22 days, and its relative error is 0.03.

An EQ 8.2 in Iquique, northern Chile, occurred on 2014–04–01. In the paper (Hu et al., 2013) we have also analyzed the EQs in south-central Chile and found that its commensurable value is equal to 0.59 years. For strict scientific purposes, the EQ events we selected are expanded to include northern Chile, and obtained their commensurable value to be still equal to 0.59 year. The previous EQ 8.0 in Chile occurred on 2010–02–27, i.e. 2010.15, so

$$2014{-}04{-}01 = 2010.15 + 0.59 \times 7 = 2014.28 = 2014{-}04{-}12 - 11 \text{ days} \ .$$

It occurred just at the commensurable point equal to seven times of its time axis. Its absolute error is 11 days, and its relative error is 0.05.

4. CONCLUDING REMARKS

Previous research has shown that Titius-Bode law not only is applicable for the planets of the solar system, but is also applicable for satellites of Jupiter, Saturn, Uranus, etc., only their concrete expressions have different forms (Zhang et al., 1980). Titius-Bode law itself brings to light the distribution law of the matter in a space region, and the expanding Titius-Bode law reveals the time law of the occurrence of the events in a specified space region. It can be seen that the commensurability is present in various natural phenomena and has universality. Therefore, astronomical achievements not only provide service to astronomical developments, but also to other scientific research, such as applied geoscience. It is helpful to study the complicated relationships among various matters, and thus merits further in-depth research.

5. REFERENCES

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