Application of Titius – Bode Law in Earthquake Study
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Abstract

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 earthquakes. So, the studies on the earthquake time distribution and prediction is of large importance for the assessment of the ITRF stability.

This article introduces application of the commensurability revealed by Titius-Bode Law in earthquake prediction study. The results show that most of the world’s major earthquake occurred at their commensurable points of time axis. The EQ 7.0 occurred in Lushan of China on 2013-04-20 and the EQ 8.2 occurred in Iquique of northern Chile on 2014-04-01 both occurred at their commensurable points of time axis. This provides an important scientific basis for the prediction of major earthquakes, which will occur in the area in future.

Introduction

During recent years huge earthquakes (EQ) frequently occurred and made surprise attacks on many places of the globe, especially in the south and east of Asian, and around the seismic belt around the Pacific Ocean. Since the EQ M9.0 occurred in Sumatra in 2004, then the EQ M8.2 in Chile in 2010, the EQ M9.0 in Honshu in 2011, the EQ M8.2 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. On the basis of the many years’ research and development of Titius-Bode law we compiled a Fortran program. By the program we systematically analyzed major earthquake in the world since 1900.0., and found that most of the world’s major earthquake occurred at their commensurable points of time axis (Hu et al., 2013). The EQ 7.0 occurred in Lushan of China on 2013-04-20 and the EQ 8.2 occurred in Iquique of northern Chile on 2014-04-01 both occurred at their commensurable points of time axis. This once again proves the universality of the commensurability.

Titius-Bode law and its expansion

From Titius-Bode law the distance of the planet n from the sun can be expressed as:

\[ a_n = 0.4 + 0.32 \times 2^{n-2}. \]  

It also can be written as the following form:

\[ \beta = \frac{a_{n+1}}{a_n}, \]  

where \( a_n \) is the distance of the planet n to the sun, reckoned in astronomical unit, and \( n \) is the number of the planets away from the sun to the far side. For Mercuryle number \( n \) is not 1, instead it is taken as \( \beta \). It is the commensurable value for the planets in the solar system (Zhang et al., 1980). As Weng Wenbo (Weng, 1981), famous Chinese geophysicist, pointed out: the commensurability is one of the orders in the natural world. The equation (2) itself 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):

\[ \Delta X = \frac{X_{i+1} - X_i}{K}, \]  

where \( \Delta \) is difference between the serial number \( i \) and \( i+1 \) of the data set \( X \). The subscript \( i \) is difference between the serial number of the first column of table 7. (See table 1). In our practical analysis and computation, \( \Delta i = 1 \). If \( K \) is equal to 1, then \( \Delta X \) is the period of \( X \) (Weng, 1981).

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 EQ may occur (Hu et al., 2013). In the paper we analyzed the commensurability of the earthquakes in the Sichuan-Yunnan region since 1900.0 and obtained its commensurable value is 2.44 year. Its previous EQ of M7.4 is the Wenchuan EQ 8.0 occurred on 2008-05-12, so 2013– 04 – 20 = 2008.36 – 2.44 = 2013.00 + 22 days. It occurred just at the commensurable point equal to 2 times of its time axis. Its absolute error is 22 days. 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 its commensurable value is 0.59 years. For strict scientific purposes, the EQ events we select are expanded to include northern Chile, and obtained their commensurable value is still 0.59 year by means of calculation and analysis of the Fortran program (Table 1). The previous EQ 8.0 in Chile occurred on 2010-02-27, so 2010.15 – 0.59 = 2014.28 – 2014*04*12 = 11 days.

It occurred just at the commensurable point equal to 7 times of its time axis. Its absolute error is 11 days. Its relative error is 0.05.

Concluding remarks

Research has shown that Titius-Bode law not only is applicable for the planets of the solar system, but also applicable for satellites of Jupiter, Saturn and 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 geology. It is helpful to study the complicated relationships among various matters, and thus merits further in-depth research.

References

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