

# nature

The Living Record of Science

《自然》百年科学经典

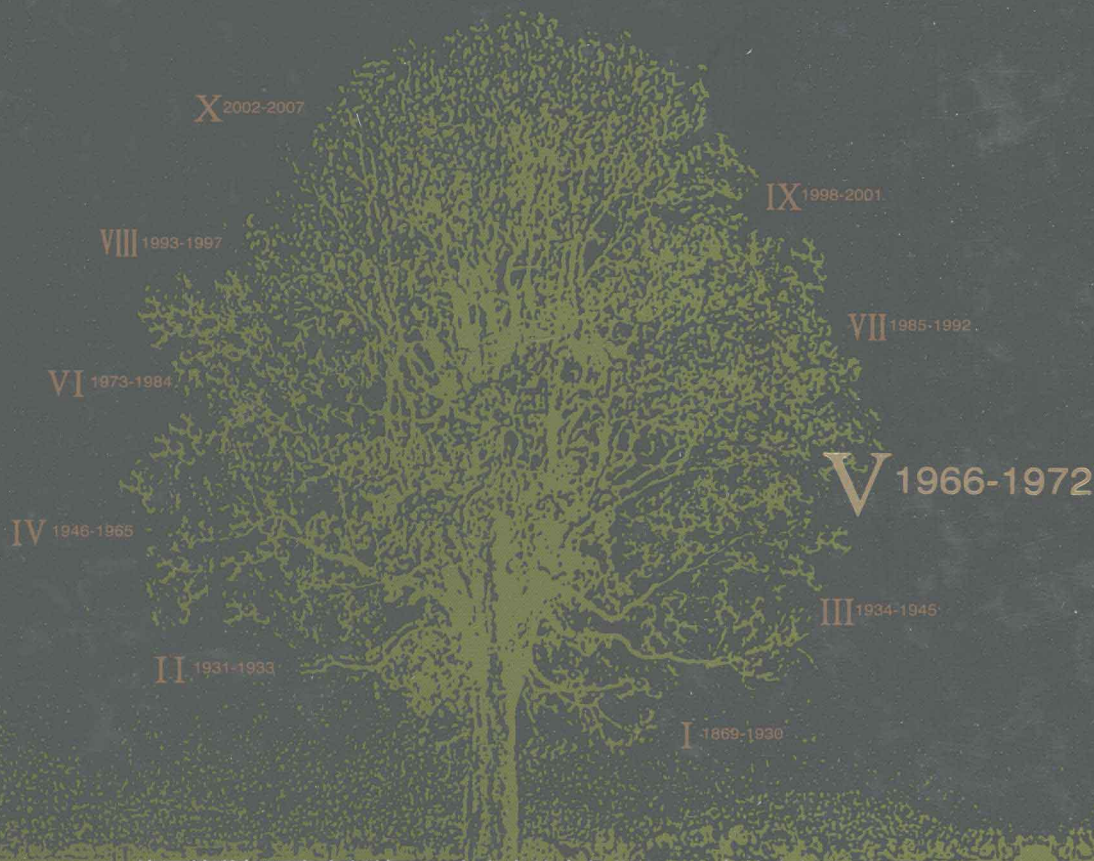
(英汉对照版)

## 第五卷

总顾问：李政道 (Tsung-Dao Lee)

英方主编：Sir John Maddox  
Philip Campbell

中方主编：路甬祥



外语教学与研究出版社 · 麦克米伦出版集团 · 自然出版集团

FOREIGN LANGUAGE TEACHING AND RESEARCH PRESS · MACMILLAN PUBLISHERS LTD · NATURE PUBLISHING GROUP

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北京 BEIJING

京权图字: 01-2011-5392

Original English Text © Nature Publishing Group

Chinese Translation © Foreign Language Teaching and Research Press

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### 图书在版编目(CIP)数据

《自然》百年科学经典. 第5卷, 1966~1972: 英汉对照 / (英) 马多克斯 (Maddox, J.), (英) 坎贝尔 (Campbell, P.), 路甬祥主编. — 北京: 外语教学与研究出版社, 2011. 11  
ISBN 978-7-5135-1481-1

I. ①自… II. ①马… ②坎… ③路… III. ①自然科学—文集—英、汉 IV. ①N53

中国版本图书馆 CIP 数据核字 (2011) 第 234907 号

出版人: 蔡剑峰

项目负责: 王 勇 章思英 Bernadette Longley (澳大利亚)

责任编辑: 何 铭

装帧设计: 孙莉明

出版发行: 外语教学与研究出版社

社 址: 北京市西三环北路 19 号 (100089)

网 址: <http://www.fltrp.com>

印 刷: 北京华联印刷有限公司

开 本: 787×1092 1/16

印 张: 76.5

版 次: 2011 年 12 月第 1 版 2011 年 12 月第 1 次印刷

书 号: ISBN 978-7-5135-1481-1

定 价: 568.00 元

\* \* \*

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物料号: 214810001

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**Volume V**  
**(1966-1972)**

# Stonehenge—An Eclipse Predictor

F. Hoyle

## Editor's Note

During the 1960s there was considerable interest in, and debate about, the purpose of the ancient Stonehenge monument in western England. While British astronomer Fred Hoyle was not the first to suggest that Stonehenge was used to predict eclipses, he does demonstrate here how it could more accurately predict them if the "Aubrey circle" represents the ecliptic (the plane of the Solar System, in which the planets orbit the Sun).

THE suggestion that Stonehenge may have been constructed with a serious astronomical purpose has recently received support from Hawkins, who has shown<sup>1</sup> that many alignments of astronomical significance exist between different positions in the structure. Some workers have questioned whether, in an arrangement possessing so many positions, these alignments can be taken to be statistically significant. I have recently reworked all the alignments found by Hawkins. My opinion is that the arrangement is not random. As Hawkins points out, some positions are especially relevant in relation to the geometrical regularities of Stonehenge, and it is these particular positions which show the main alignments. Furthermore, I find these alignments are just the ones that could have served far-reaching astronomical purposes, as I shall show in this article. Thirdly, on more detailed investigation, the apparently small errors, of the order of  $\pm 1^\circ$ , in the alignments turn out not to be errors at all.

In a second article<sup>2</sup> Hawkins goes on to investigate earlier proposals that Stonehenge may have operated as an eclipse predictor. The period of regression of the lunar nodes, 18.61 years, is of especial importance in the analysis of eclipses. Hawkins notes that a marker stone moved around the circle of fifty-six Aubrey holes at a rate of three holes per year completes a revolution of the circle in 18.67 years. This is close enough to 18.61 years to suggest a connexion between the period of regression of the nodes and the number of Aubrey holes. In this also I agree with Hawkins. I differ from him, however, in the manner in which he supposes the eclipse predictor to have worked. Explicitly, the following objections to his suggestions seem relevant:

(1) The assumption that the Aubrey holes served merely to count cycles of 56 years seems to me to be weak. There is no need to set out fifty-six holes at regular intervals on the circumference of a circle of such a great radius in order to count cycles of fifty-six.

(2) It is difficult to see how it would have been possible to calibrate the counting system proposed by Hawkins. He himself used tables of known eclipses in order to find it. The builders of Stonehenge were not equipped with such *post hoc* tables.

# 巨石阵——日月食的预报器

霍伊尔

## 编者按

在 20 世纪 60 年代，英格兰西部古老巨石阵的用途是大家非常关注和存在争议的问题。虽然第一个提出巨石阵是用于预测日月食的工具的人并非英国天文学家弗雷德·霍伊尔，但他在这里解释了在“奥布里环”代表黄道面（即太阳系的运行平面，所有行星都在这个平面内绕太阳运动）的前提下如何利用巨石阵更精确地预言日月食。

巨石阵可能是出于一个重要的天文目的而修建的，这一假设最近得到了霍金斯的支持。他指出<sup>[1]</sup>，在该建筑的不同位置中存在着有天文学意义的准线。一些研究者曾质疑：在一个拥有如此多方位的布局中，这些准线是否应该被认为具有统计学上的显著性。最近我检验了霍金斯发现的所有准线。我认为这个布局不是随机的。正如霍金斯所指出的，有些位置与巨石阵的几何规律之间有特殊的关联，而主要的准线正是在这些特殊位置上发现的。其次，我还发现这些准线恰好就是能长期服务于天文学观测需要的准线，在本文中我会解释这一点。第三，根据更加细致的调查，在这些准线中看似存在的量级为  $\pm 1^\circ$  的小偏差其实根本就算不上偏差。

在第二篇文章中<sup>[2]</sup>，霍金斯又对早先的一个假说进行了研究，即认为巨石阵可能曾用于预报日月食。月球交点的回归周期为 18.61 年，这一周期在日月食分析中是非常重要的。霍金斯指出：有一个石标以每年 3 个洞的速率沿着由 56 个奥布里洞组成的圆周运动，旋转一周所用的时间恰好是 18.67 年。这和 18.61 年非常接近，因而说明月球交点的回归周期与奥布里洞的数量之间是存在相关性的。在这一点上我也同意霍金斯的观点。不过，我与他的分歧之处在于他所说的预测日月食的方式。显然，以下几条对其所持观点的反对意见看起来是合理的：

(1) 在我看来，假设奥布里洞仅仅是被用于计算 56 年的循环未免有点站不住脚。没有必要为了表示出 56 年的循环，而在这么大半径的圆周上以一定的间距建造 56 个洞。

(2) 很难解释古人是如何校准由霍金斯所提出的计算系统的。为了找到这一系统，他本人使用了已发生过的日月食的记录表。巨石阵的建造者们哪里会有这些在日月食发生之后才统计出的表格。



(3) The predictor gives only a small fraction of all eclipses. It is difficult to see what merit would have accrued to the builders from successful predictions at intervals as far apart as 10 years. What of all the eclipses the system failed to predict?

My suggestion is that the Aubrey circle represents the ecliptic. The situation shown in Fig. 1 corresponds to a moment when the Moon is full. The first point of Aries  $\gamma$  has been arbitrarily placed at hole 14.  $S$  is the position of the Sun, the angle  $\odot$  is the solar longitude,  $M$  is the projection of the Moon on to the ecliptic,  $N$  is the ascending node of the lunar orbit,  $N'$  the descending node, and the centre  $C$  is the position of the observer. As time passes, the points  $S$ ,  $M$ ,  $N$  and  $N'$  move in the senses shown in Fig. 1.  $S$  makes one circuit a year.  $M$  moves more quickly, with one circuit in a lunar month. One rotation of the line of lunar nodes  $NN'$  is accomplished in 18.61 years. In Fig. 1,  $S$  and  $M$  are at the opposite ends of a diameter because the diagram represents the state of affairs at full Moon.

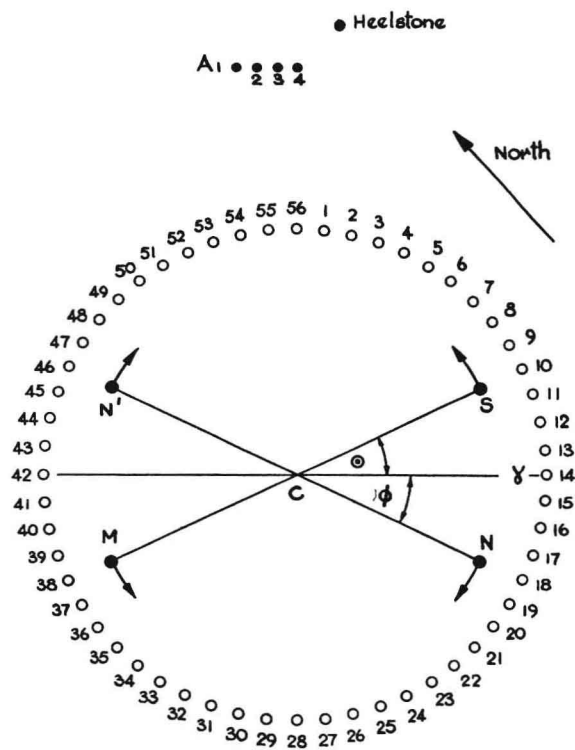


Fig. 1

If the Moon is at  $N$ , there is a solar eclipse if the Sun is within roughly  $\pm 15^\circ$  of  $N$ , and a lunar eclipse if the Sun is within  $\pm 10^\circ$  of  $N'$ . Similarly, if the Moon is at  $N'$ , there will be a solar eclipse if the Sun is within  $\pm 15^\circ$  of coincidence with the Moon, and a lunar eclipse if it is within roughly  $\pm 10^\circ$  of the opposite end of the line of lunar nodes. Evidently if we represent  $S$ ,  $M$ ,  $N$  and  $N'$  by markers, and if we know how to move the markers so as to

(3) 这种预报方法只预测出了全部日月食中很小的一部分。很难理解这些建造者们会因为成功预言间隔可达 10 年之久的日月食而得到什么好处。怎么解释那么多该系统没有预言出来的日月食呢？

我的观点是奥布里环代表了黄道。图 1 所示的位置对应于满月时的位置。任意取白羊座  $\gamma$  作为第一个点放在第 14 号洞处。 $S$  是太阳的位置， $\odot$  角代表黄经， $M$  是月球在黄道面上的投影， $N$  是月球轨道的升交点， $N'$  为降交点，中心  $C$  是观测者所在的位置。随着时间的流逝， $S$ 、 $M$ 、 $N$  和  $N'$  点会按图 1 所示的方式运动。 $S$  每年转一圈。 $M$  运行得会更快一些，一个朔望月循环一周。两个月球交点所连成的直线  $NN'$  旋转一周的时间为 18.61 年。在图 1 中， $S$  和  $M$  位于一条直径的两端是因为这张图代表的是满月时的状态。

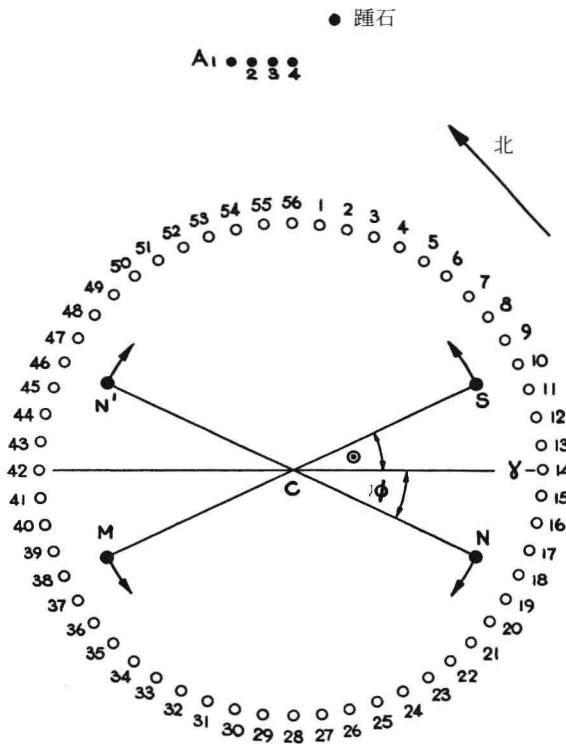


图 1

如果月球位于  $N$  点，那么当太阳在距离  $N$  点大致  $\pm 15^\circ$  范围之内时就会发生一次日食；而当太阳在距离  $N'$  点  $\pm 10^\circ$  范围之内时就会发生一次月食。同样，如果月球位于  $N'$  点，那么当太阳在距离月球位置  $\pm 15^\circ$  范围之内时就会发生一次日食；而当太阳在距离两个月球交点连线的另外一端大致  $\pm 10^\circ$  范围之内时就会发生一次月