太阳日冕环的运动（Ⅰ）、（Ⅱ）

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提要

几年以前天空实验室的观测发现太阳日冕中多数瞬变过程是以环状形式发生质量喷射，并且测得环状瞬变过程前导边缘是加速运动或者是等速运动。这些日冕环是细长的环。环中的磁能密度大约是热能密度的十倍。观测表明：磁场是控制日冕环的主要因素。

至今，关于日冕瞬变过程的理论模型有四种：纯流体模型、MHD数值模拟模型、电流环模型和爆发日珥与瞬变过程相结合的模型。在磁能占优势的日冕环中，非磁驱动机制的模型1和2难于证明是正确的。

在报告（Ⅰ）中我们曾在$Anzer$电流环模型基础上，分析了日冕环小环方向的平衡，考虑了日冕环中等离子体压力产生的推动力，得到日冕环顶部的运动方程和使日冕环产生加速运动所需要的最小的电流条件，并且对不同的初始条件进行数值计算。

在报告（Ⅱ）中我们提出一种推动日冕环加速运动机制，即磁环模型。在磁环模型中，日冕瞬变过程好象是一个环状磁力线管。由于磁力线管中环向磁场分布不均匀产生向外的推动力，驱动日冕环加速运动。

假设日冕环中环向磁场的分布为

$$B_Z=B_0 r_1{}^n, \quad n=1, \ 2, \ 3, \ \cdots\cdots$$

B_0为常数。分析作用在日冕磁环顶端部分上的各种力，得到日冕环顶部的无量纲的运动方程为

$$\frac{d^2R}{dt^2}=\frac{n}{4(n+1)}\frac{f(R)}{j(R_0)}\frac{ra^2B_a^2}{Rr_0}-g\left(\frac{1}{R}\right)^2$$

给定不同的初始条件下，给定不同的磁场大小或者不同的环向磁场分布。对运动方程求数值解，得到日冕环顶部速度随太阳表面上高度的变化曲线。计算结果与观测结果大体相一致。对应于观测的日冕环顶部速度范围磁环中表面上的环向磁场强度在0.4～0.8高斯范围内。当环向磁场小于0.4高斯时，则很快地成为减速运动。

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The Accelerating Motion of Solar Coronal Loops (I) (II)

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Abstract

The ejection of coronal mass in the form of loop transients was discovered during the skylab, and the white—light coronagraph shows that the outward motion of the coronal transients accelerated or remained at an approximately constont velocity. These loops were like elongated structures. The magnatic energy density for the transient was about 10 times the thermal energy density, indicating that the plasma was magnetically controlled.

There are four types of the theoretical models of coronal transients—the purely hydrodynamical mode, the MHD numerical modeling mode, the ring current mode and the eruptive prominence and transient mode. As to the first two types one problem is that they evoke purely thermal or nonmagnetic driving forces. Since the magnetic energy dominates in these events ($\beta < 1$), a nonmagnetic driving mechanism is difficult to justify.

In the first paper, the Anzer's model is restudied, the equilibrium in the direction of the minor radius of the loop is analysed, and the driving force produced by the plasma pressure is considered. The equation of motion of a section of the coronal loop top and the minimum current of the accelerated motion of the coronal loop are given, and the numerical calculation is completed for the given different initial conditions.

In the second paper, we suggest a magnetic loop model, in which the coronal loop is a loop—like magnetic tube of force. The forces driving the coronal loop are produced by the nonhomogeneous distribution of the longitudinal magnetic fields in the magnetic loop. The coronal loop is a slender one.

Given the distribution of the longitudinal magnetic fields on the coronal loop

$$B_Z = B_0 r_1^n, \quad n = 1, 2, 3, \cdots\cdots$$

where B_0 is a constant, after analysing the various forces that are exerted on the top fo the coronal loop, one can obtain the equation of motion of the coronal loop top

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$$\frac{d^2R}{dt^2}=\frac{n \quad f(R)\, ra^2B_a^2}{4(n+1)f(R_o)R\, r_o}-g\,(\frac{1}{R})^2 \qquad (1)$$

The numerical calculations from Equation (1) is completed for the given different initiol conditions. The results are compared with those observed during the skylab period from May 1973 to January 1974. The former is largely in accordance with the later.

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