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# Algol型双星的观测研究

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Algol型双星是双星的一种, 其独特的半接结构使它拥有丰富的物理现象, 包括严重畸变的充满子星、强磁活动现象, 物质转移的各种形式, 完全迥异于单星的演化状态和特有的形成历史. 本文对双星光变曲线的基础物理做了介绍, 同时介绍了历史上的各个模型或程序. 展示了各个物理参数对光变曲线的影响, 包括倾角、温度、金属丰度、表面重力加速度、第3光、半径、轨道椭率和轨道近点角等. 根据已有星表统计了Algol型双星的性质, 并对3颗样本星进行了具体的观测和分析, 结果如下:

(1) 对Algol型双星进行了统计分析, 结果支持前人的分离子星大多为主序星的结论. 质量比的分布支持我们对于Algol型双星质量比临界值的理论计算, 同时猜测Algol型双星的半径比可能存在下限. 发现Algol型双星中两子星的温度、光度、半径和质量等都具有较好的相关性.

(2) 观测并分析了双星FG Gem. 基于不同温度、光度组合的大量的解轨参数, 使用新的对比年龄的方法得出双星FG Gem是半接双星的结论. 使用新的温度搜寻的方法改善了对分离子星温度的估计值. 对FG Gem特殊的周期变化, 提出原因可能是间断性物质流和持续的磁滞的共同作用.

(3) 以双星VV Vir为例, 讨论了Algol型双星中物质流的一些性质. 某些性质可以反映半接系统中物质流的一些共性, 包括: 流的半径很小, 进而造成的撞击斑的半径也很小. 在物质转移率较高的情况下, 物质流的能量转移率可以比拟分离子星的本征光度. 撞击斑的位置由周期、质量比和分离子星的无量纲势决定. 撞击斑的温度很高, 并能够以驼峰的形式直接反映在光变曲线上.

(4) 发现了1颗罕见的正处在质量比反转过程中的Algol型双星V753 Mon, 这颗双星的质量比非常接近1, 处在双星演化的关键阶段, 为双星演化理论提供了观测标本.

(5) 介绍了光变曲线模型及其各个物理因素, 包括轨道的形状、恒星的形状、引力致亮效应、恒星大气模型、临边昏暗效应、反射效应、掩食效应、第3天体及第3光、黑子和磁效应、热斑、恒星震动、大气掩食和星周物质等. 梳理并介绍了历史上的各个光变曲线分析程序. 对光变曲线的参数逐一进行了分析和结果展示, 包括轨道倾角、恒星表面温度、表面金属丰度、表面重力加速度、第3光、恒星半径(由表面势表述)、双星轨道椭率和近点角等.

# An Observational Study of Algol-Type Binary System

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The Algol-Type binary systems are a subtype of binary systems. Their unique semi-detached structure leads to have abundant physical phenomena, including the dramatically distorted donor star, strong magnetic activities, various ways of mass transfer, the evolution stage quite different from that of single stars, and specific formation tracks. In this paper,

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we introduce the fundamental physics of light curves, as well as the models or programs used in the past. We show the influence of different parameters on the light curves, including the inclination, temperature, abundance, surface gravity, the third light, radius, orbital eccentricity, and the argument of periastron. Based on the current catalog of Algols, we investigate their statistic characteristics. We observe three Algols and analyze the data in detail. The results are as follows:

(1) Our statistical analyses of Algols support the previous suggestion that most of the detached component stars are main sequence stars. The distribution of the mass ratio agrees to our calculated critical value of the mass ratio for Algols. We suggest that there could be a lower limit of the radius ratio. We also show that there are good correlations among the temperature, luminosity, radius, and the mass of the component stars.

(2) The binary FG Gem is observed, and the data are analyzed. Based on the solutions of large combinations of the temperature and luminosity, we use a new age-comparing method to show that the FG Gem is a semi-detached system, and a new temperature-searching method to get a better estimate of the temperature of the detached component star. We suggest that a combination of the intermittent mass flow and the continuous magnetic braking can explain its orbital period change.

(3) Taking the VV Vir as an example, we discuss some properties of the mass flow in a semi-detached binary. Some of them can reflect the common characteristics of the mass flows in the Algol systems, e.g., the radius of the mass flow is very small, so is its impact spot. If the mass transfer rate is high, the energy transfer rate can be comparable to the intrinsic luminosity of the detached component star. The position of the impact spot can be determined by the orbital period, mass ratio, and the dimensionless potential. The temperature of the impact spot is very high, and it can be directly reflected by the humps on the light curves.

(4) We discover a rare Algol binary V753 Mon, which is just in the process of mass ratio inversion. The mass ratio of this binary is very close to one, and the key evolutional stage provides an important observational source for the theoretical studies of binary evolution.

(5) We introduce the light curve models and the related physical factors, including the shape of the orbit, the shape of the stars, gravity brightening, atmosphere model, limb darkening, reflection effect, eclipse effect, the third body and its third light, dark spots and magnetic effect, hot spots, asteroseismology, atmospheric eclipse, and circumstellar matter. The light curve analysis programs are presented. We analyze the parameters and show the relevant results, including the orbital inclination, surface temperature, metal abundance, gravity acceleration, the third light, stellar radius (expressed by the surface potential), the eccentricity of the orbit, and anomaly.