ANALYSIS OF EUV LIMB-BRIGHTENING OBSERVATIONS FROM ATM

I: Model for the Transition Layer and the Corona

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(Received 23 May; in revised form 30 June, 1975)

Abstract. Limb-brightening curves for EUV resonance lines of O vI and Mg x have been constructed from spectroheliograms (5° resolution) of quiet limb regions observed with the Harvard experiment on Skylab. The observations are interpreted with a simple model for the transition layer and the corona. A comparison of theoretical and observed limb-brightening curves indicates that the lower boundary of the corona, where \( T_e = 10^6 \text{K} \), is at a height of about 8000 km in typical quiet areas. For \( 1.01 R_\odot \leq r < 1.25 R_\odot \), the corona can be represented by a homogeneous model in hydrostatic equilibrium with a temperature of \( 10^6 \text{K} \) for \( 1.01 R_\odot \leq r < 1.1 R_\odot \) and \( 1.1 \times 10^6 \text{K} \) for \( r > 1.1 R_\odot \). The model for the transition layer is inhomogeneous, with the temperature gradient a factor of 3 shallower in the network than in the intranetwork regions. It appears that spicules should be included in the model in order to account for the penetration into the corona of cool \( (T_e < 10^6 \text{K}) \) EUV-emitting material to heights up to 20000 km above the limb.

1. Introduction

A major problem in solar physics is the derivation of a reliable model for the physical conditions in the solar chromosphere, chromosphere-corona transition layer, and corona. Knowledge of the temperature, density, and magnetic structure of these layers is of basic importance to the specification of the mass and energy balance in the upper solar atmosphere and the determination of requirements for mechanical heating in these layers. Recent observations and theoretical models for the transition layer and low corona (e.g., Brueckner and Bartoe, 1974; Gabriel, 1974, 1975; Kopp, 1972; Reeves et al., 1974a, 1975) indicate that the chromospheric network plays a fundamental role in determining where extreme-ultraviolet (EUV) radiation is emitted. This paper reports results of an analysis of solar limb brightening in a typical quiet area using Skylab observations of EUV lines from the lithium-like ions O vI and Mg x. The purpose of this analysis is the evaluation of the influence that inhomogeneities associated with the chromospheric network have on the temperature and density structure of the transition layer and corona.

2. Observations

From observations obtained with the Harvard experiment (Reeves et al., 1974b) on the Skylab Apollo Telescope Mount, a typical quiet limb region, approximately 45°N of the east limb on 28 January 1974, was selected for study. The region was devoid...
of coronal holes and active regions. The data consist of spectroheliograms acquired simultaneously over a period of 5 min in the lines L x \( \lambda 1216 \), C II \( \lambda 1335 \), C III \( \lambda 977 \), O IV \( \lambda 554 \), O VI \( \lambda 1032 \), and Mg X \( \lambda 625 \). Each individual spectroheliogram is made up of a 60 x 120 array of photoelectric intensity measurements centered just above the solar limb and covering a 5' x 5' area with a spatial resolution of 5". For the present analysis, we utilized the two lines from the lithium-like ions, O VI \( \lambda 1032 \) and Mg X \( \lambda 625 \). Because the assumption of a two-level atom is adequate for these two

![Fig. 1. Quiet solar-limb area approximately 45°N of east obtained on 5 January 1974 at 2120 GMT. Progressively lighter shades of gray correspond to increasing intensities.](image-url)