Abstract  One of the major discoveries of the Extreme ultraviolet Imaging Telescope (EIT) on SOHO was the intensity enhancements propagating over a large fraction of the solar surface. The physical origin(s) of the so-called EIT waves is still strongly debated with either wave (primarily fast-mode MHD waves) or nonwave (pseudo-wave) interpretations. The difficulty in understanding the nature of EUV waves lies in the limitations of the EIT observations that have been used almost exclusively for their study. They suffer from low cadence and single temperature and viewpoint coverage. These limitations are largely overcome by the SECCHI/EUVI observations onboard the STEREO mission. The EUVI telescopes provide high-cadence, simultaneous multitemperature coverage and two well-separated viewpoints. We present here the first detailed analysis of an EUV wave observed by the EUVI disk imagers on 7 December 2007 when the STEREO spacecraft separation was \( \approx 45^\circ \). Both a small flare and a coronal mass ejection (CME) were associated with the wave. We also offer the first comprehensive comparison of the various wave interpretations against the observations. Our major findings are as follows: (1) High-cadence (2.5-minute) 171 Å images showed a strong association between expanding loops and the wave onset and significant
differences in the wave appearance between the two STEREO viewpoints during its early stages; these differences largely disappeared later; (2) the wave appears at the active region periphery when an abrupt disappearance of the expanding loops occurs within an interval of 2.5 minutes; (3) almost simultaneous images at different temperatures showed that the wave was most visible in the 1 – 2 MK range and almost invisible in chromospheric/transition region temperatures; (4) triangulations of the wave indicate it was rather low lying ($\approx 90$ Mm above the surface); (5) forward-fitting of the corresponding CME as seen by the COR1 coronagraphs showed that the projection of the best-fit model on the solar surface was inconsistent with the location and size of the co-temporal EUV wave; and (6) simulations of a fast-mode wave were found in good agreement with the overall shape and location of the observed wave. Our findings give significant support for a fast-mode interpretation of EUV waves and indicate that they are probably triggered by the rapid expansion of the loops associated with the CME.

**Keywords** Flares, dynamics · Corona

### 1. Introduction

One of the major discoveries of EIT on SOHO (Delaboudinière et al., 1995) was the existence of conspicuous large-scale EUV propagating intensity disturbances. These intensity fronts sometimes have the appearance of an almost circular wave front and are frequently called EIT or EUV waves (e.g., Moses et al., 1997; Thompson et al., 1998, 1999). EUV waves are normally first seen in close proximity to a flaring and erupting active region and they subsequently propagate over a significant fraction of the visible surface before they become too faint to be detected. EIT observations indicate that they travel at speeds of $50 – 400$ km s$^{-1}$. Statistical studies showed that they are mostly associated with coronal mass ejections (CMEs) and not with flares (e.g., Biesecker et al., 2002). There is a tendency for the fastest EUV waves to be associated with similar phenomena in H$\alpha$, chromospheric He I, and soft X rays and to produce type II radio bursts (e.g., Moreton, 1960; Athay and Moreton, 1961; Klassen et al., 2000; Kahler and Hudson, 2001; Cliver et al., 2005; Narukage et al., 2002; Hudson et al., 2003; Gilbert et al., 2004; Vršnak et al., 2006). There is an extensive literature on this subject (e.g., Wills-Davey and Thompson, 1999; Delannée, 2000; Klassen et al., 2000; Kahler and Hudson, 2001; Wu et al., 2001; Narukage et al., 2002; Ofman and Thompson, 2002; Gilbert et al., 2004; Zhukov and Auchère, 2004; Podladchikova and Berghmans, 2005; Warmuth and Mann, 2005; Veronig et al., 2006; Vršnak et al., 2006). Reviews on the topic can be found in Chen and Fang (2005), Gopalswamy et al. (2006), Pick et al. (2006), Schwenn et al. (2006), and Warmuth (2007).

Despite the extensive research on these phenomena, significant controversy remains over the physical origin(s) of the EUV waves. One interpretation states that EUV waves are global fast-mode waves triggered by the associated flare or CME (e.g., Thompson et al., 1999; Wang, 2000; Wu et al., 2001; Ofman and Thompson, 2002). The expectation of finding fast-mode waves in the corona was originally considered by Uchida (1968). Fast-mode waves can travel large distances over the solar surface since they can propagate at right angles with respect to the ambient, (radial to a first approximation) magnetic field of the quiet Sun regions, which occupy most of the solar surface, particularly during solar minimum conditions. Moreover, they have a compressive character, which can lead to the intensity enhancement associated with the EUV waves. In what follows we will refer to this interpre-