Streamer wave events observed with STEREO/COR2

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Introduction

Recently, transverse waves were observed in helmet streamers, typically after the passage of a coronal mass ejection (CME). The CME-driven shock wave moved the streamer sideways, and a decaying oscillation of the streamer was observed after the CME passage. All the previous works reported observations of streamer oscillations taken from a single vantage point (typically the SOHO spacecraft). We conduct a data survey searching for streamer wave events observed by the COR2 coronagraph onboard the STEREO spacecraft. For the first time, we can observe streamer wave events from multiple vantage points, by using the COR2 instrument on both STEREO A and B.

		CME				Streamer		
Date	Visible from STEREO	Time (UT)	Speed (km/s)	CPA (deg)	Width (deg)	Start Oscillation (UT)	CPA (deg)	Phase speed (km/s)
17/05/2008	A	10:37	863	102	58	11:07	125	597
7/04/2011	A & B	12:24	457.5	210	90	12:54	280	662.1
27/04/2011	A & B	2:54	694	54	58	3:24	135	493.6
4/06/2011	A & B	22:24	1136	323	352	22:54	140	637.6
20/06/2011	A & B	18:24	431	274	86	18:39	250	407
4/08/2011	A	3:54	1193	22	234	4:54	324	537.5
11/05/2012	A	22:54	657	85	96	00:09+1	143	455.4
17/05/2012	B	2:24	781	323	352	2:39	219	571.9
14/06/2012	A	13:24	961	49	180	14:54	17	508.7
6/02/2013	A	0:24	543	30	74	0:39	90	486.5
13/03/2013	A & B	0:24	368	254	46	0:24	211	424.9
1/05/2013	A	3:24	833	301	104	3:39	10	490.6
1/05/2013	A	3:24	833	301	104	3:24	234	526.8
14/05/2013	A	21:24	781	339	268	23:39	11	640.7
27/05/2013	A	19:54	520	217	56	20:09	175	440.3
18/04/2014	A & B	10:54	892	153	304	14:24	97	312

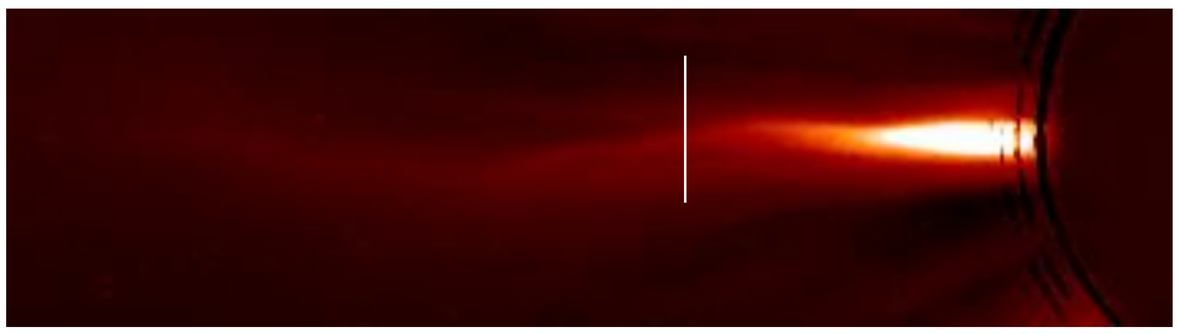

Figure 1: Snapshot of oscillation on 06-02-2013, captured by STEREO A/COR2. Time of snapshot is 02:39UT. Cropped image of the box in Figure 5. The white line represents the slit along which the time-distance map is made.

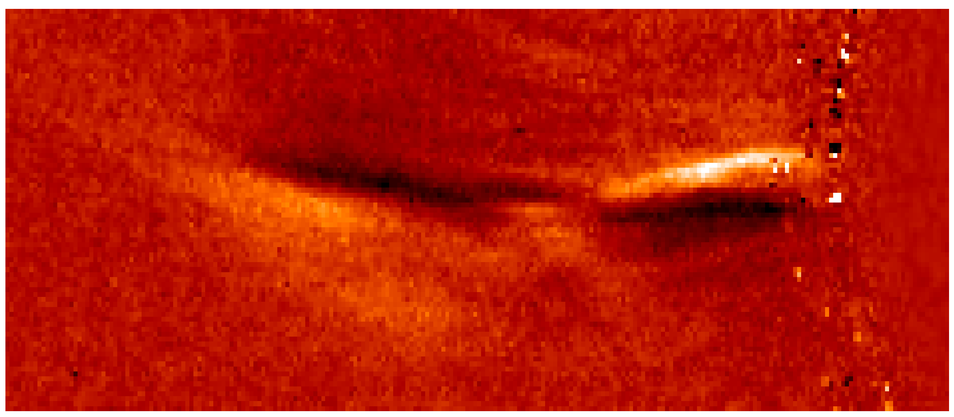

Figure 2: Snapshot of oscillation in running differences on 06-02-2013, captured by STEREO A/COR2. Time of snapshot is 01:39UT.

Event analysis

One event that we present here in more detail as an example, and in the accompanying e-poster, took place on February 6, 2013. The CME onset was at 00:24UT. The first sign of the oscillation can be seen in the next available frame, that is at 00:39UT. The cadence of the STEREO/COR2 images is 15 minutes, which prohibits us from finding the exact oscillation onset. In Figure 5, and more zoomed in in Figure 1 you can clearly distinguish the wavy signature of an oscillation. In the e-poster presentation, there is a movie available. In Figure 2 you can find a zoomed-in view of the streamer in a running differences image. Here the alternating black and white patches clearly indicate that we are dealing with an oscillation. Finally, we also made a time-distance map of the white-light images along the white slit drawn in Figure 1. The result can be found in Figure 4. Due to the low cadence of STEREO A / COR2 we have a low time resolution in this map, and as a result the wave looks jumpy. For this reason it is also hard to derive the phase speed from time-distance maps in this case. You can not know if in your chosen slit there is a time frame where you will see all the troughs and crests of the oscillation.

Data survey

We examined the STEREO A and B COR2 data for streamer oscillation events from the start of the mission in 2007 until September 2017. In this period we found 16 events, which are listed in the table in the right upper corner. We selected candidate events by going through the white-light images, and narrowed the list down by looking for clear oscillatory signatures in the running difference images. All the oscillation events we found, were the result of a streamer being disturbed by a CME. Some CMEs (large halo events) were however not listed in the CACTus CME catalog. We also derived the phase speed for every event by tracking the first clear wave crest or trough through the white-light images. In Figure 3 a scatterplot of the speed of the corresponding CME and the phase speed of the propagating wave is shown. The correlation factor between the two is 0.28. There is thus no clear correlation between them, which can also be seen on the plot. This could indicate that the oscillation characteristics are bound to the properties of the streamer, and not to those of the CME.

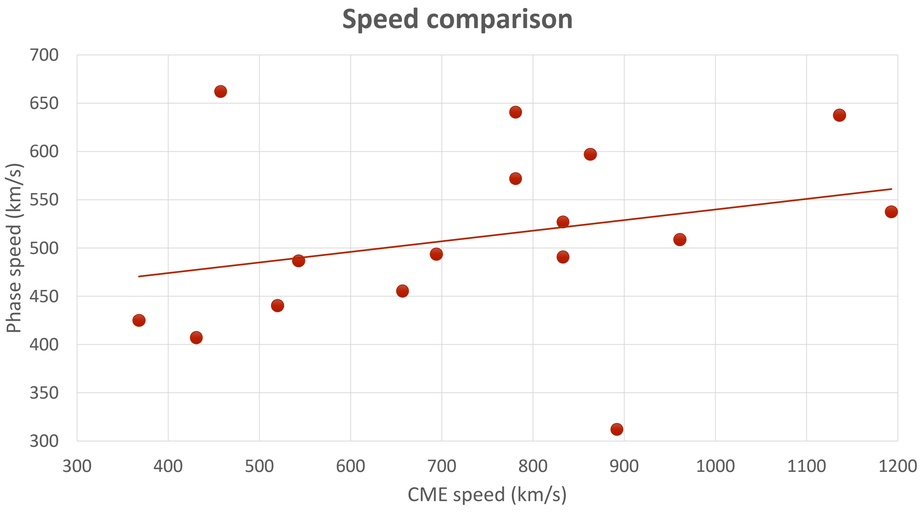

Figure 3: Scatter plot of the CME speed and the phase speed of the oscillations found in the survey

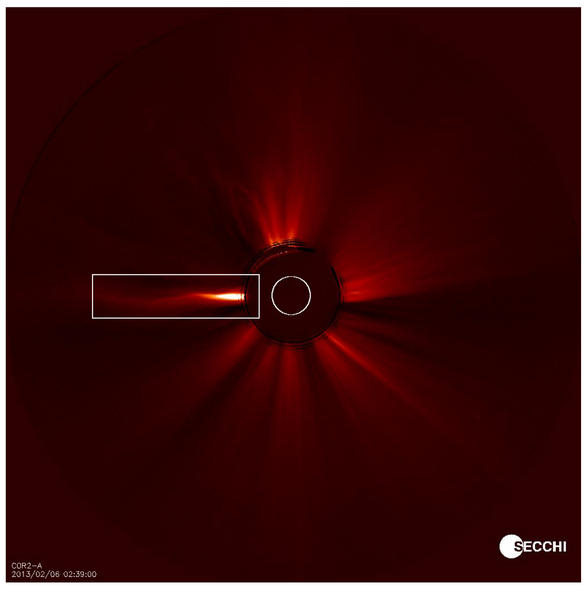

Figure 5: Snapshot of oscillation on 06-02-2013, captured by STEREO A/COR2. Time of snapshot is 02:39UT.

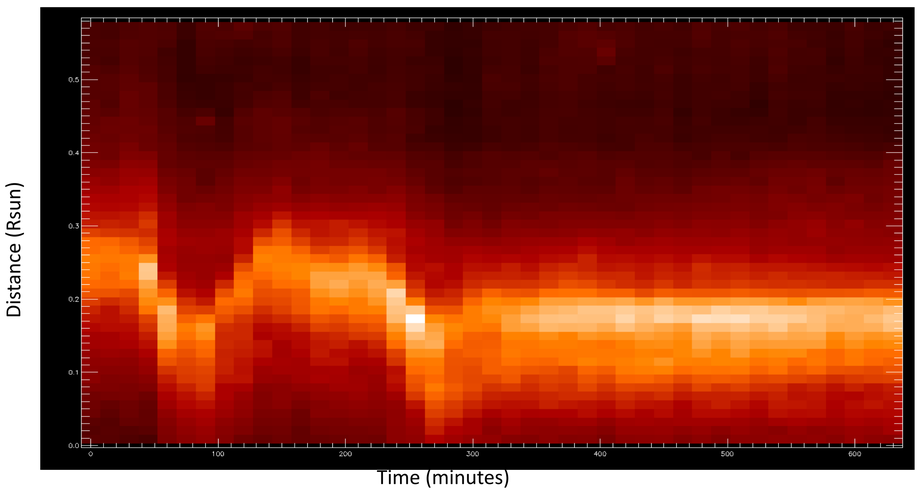

Figure 4: Time-distance map of the oscillation on 06-02-2013. Starting time is 00:24UT.

Further information
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Accompanying e-poster on Wednesday at 10:40.

Conclusion and future work

We found 16 streamer oscillation events observed by the STEREO COR2 coronagraphs, between January 2007 and September 2017. Each candidate event was analyzed in white-light and running difference images to look for clear oscillatory signatures and to determine the phase speed of the propagating wave. Since the phase speeds of the waves do not correlate with the speed of the CME by which they are hit, the wave characteristics can be guided by the streamer properties. Investigating these events in more depth can thus give us more information about the properties of coronal streamers. In the era of the STEREO mission, we have 3 coronagraphs at different locations (STEREO A and B / COR2 and SOHO / LASCO) which can give us different viewpoints on these unique events. Combining these viewpoints will give us new insights in the onset of these oscillations and how they relate to the physical properties of the coronal plasma in streamers.