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Summary:
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The manuscript describes a new instrument concept for measuring the solar wind core ion beam using a plasma spectrometer mounted on a sun-pointed spinning spacecraft.

Despite my somewhat lengthy set of comments below, I greatly enjoyed reading the paper and would like to see the realization of this technology come to fruition. Most of my concerns/comments below are either minor or general musings and some do not really require the authors to take action or respond (I noted these where necessary). Thus, I think the paper is suitable for publication in Ann. Geophys.

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General Comments:
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-- Table 1 and Section 2:
  -- I would check to make sure that the shock jumps are correct, as I recall from the CfA Shock Database that several shocks had $\Delta V > 200$ km/s.
  https://www.cfa.harvard.edu/shocks/wi_data/
  -- You should reference some recent work that provides the first long-term statistical study on solar wind parameters near 1 AU by Wilson et al. [2018] (Note the supplemental material does separate parameters by fast and slow wind).
  -- I doubt either of these will modify the values in your table very much, but they will provide at least a reference/source for the provided values.
-- Section 2.1: [The following are my musings, but are most likely not critical]
  -- I see you addressed most of my concerns below in Section 3 already, but I leave it here for reference.
  -- One thing of which to be careful are secondary/reflected ions near strong collisionless shocks. I assume you have thought of this and know how to handle it, but I should mention that even when the reflected to incident ion density is relatively low, it can affect the bulk flow velocity estimate determined from typical velocity moment software significantly. If the spacecraft on which the instrument of interest in this paper is to orbit Earth and not, say, L1, then bow shock reflected ions will be an issue and the fraction of reflected-to-incident is much higher (>25% in some cases) than typical interplanetary shocks. This can affect the bulk flow velocity causing it to devaiate away from the core solar wind proton beam by upwards of 30%, i.e., >100 km/s [e.g., Wilson et al., 2014a]. In the case of a sun-pointed spinner on an outbound pass, the number of reflected ions entering the detector will likely be small, so probably not an issue. However, the reflected ions at earthward propagating interplanetary shocks will always be an issue. The primary difference is that most interplanetary shocks do not reflect a significant enough fraction of the upstream ions to generate much of a foreshock, so perhaps this is not cause for concern?
  -- I know of at least one interplanetary shock that caused problems for the PESA Low detector from Wind/3DP that was seen on 2001-11-24 near 05:51 UT. The thermal energies got so large that the instrument lost the solar wind beam and did not enter tracking mode because it thought it was still following the beam. Granted, the mode was not as well designed as newer spacecraft that use NV (i.e., roughly the count rate) but it is worth considering.
-- Section 3.4:
  -- Be careful with the estimates of the spatial scales for discontinuities. The thickness of the shock ramp is not on ion scales, but on electron scales [e.g., Hobara et al., 2010; Mazelle et al., 2010]. What is not shown in the Spektr-R data is what was assumed for years

to be the actual shock ramp but was undersampled [e.g., see Wilson et al., 2012, 2017]. In general, I think your estimates are fine, but the statement that ion properties cannot change faster than ion scales is factually incorrect. Further, it is not the case that the fluctuations discussed in the above references have no effect on the ions, as shown by Goncharov et al. [2014].

-- Section 4.1

- -- I am confused. If you have a sun-pointed spinning spacecraft and you align the central elevation angle bin with roughly the Earth-sun line, why does the solar wind beam vary with spin in the elevation angle? Or am I misunderstanding Figure 1 and the discussion in this section? Is the spacecraft spin axis not aligned with the Earth-sun line?
- -- Page 7, Lines 27-30: I do not follow the sentence starting with "The difference between..." Is this a comment on the results shown in Figure 1 or a general comment about the solar wind?
- -- Page 8, Lines 4-5: Can you be a little more quantitative with the statement "...distributions are somewhat distorted..."? Distorted in what way? Would one interpret the VDFs as having a higher temperature than reality, for instance? If so, by how much?

-- Section 4.3

- -- Having had several long conversations with Drs. Safrankova and Nemecek (a few years ago now) about the capabilities and limitations of the BMSW instrument, I am curious how you managed to get the data into GSE coordinates. It was my understanding that there is no way to know the actual spacecraft orientation and attitude necessary to rotate the data out of spacecraft coordinates into a physically meaningful basis. Has this issue been recently resolved?
- -- The shock on 2015-06-22 arrived at L1 at ~18:08:24 UT (e.g., I looked at Wind data on CDAWeb). Regardless, the bulk flow velocity along X-GSE jumps to nearly -800 km/s in the downstream and the ion temperature exceeds 100 eV (i.e., ~1.2 MK), so the temperatures may not be too inaccurate from BMSW. The CfA shock database shows a density compression ratio of ~3.4 but I think the temperature changes by a factor >4-5. [These are just comments, not really actionable items.]
- -- Page 9, Lines 50-51: Are the temperature and temperature anisotropy significantly affected as well, or just the density moment?

-- Hot and/or Tenuous VDFs

- -- One of the biggest issues that I did not see addressed in the manuscript occurs during intervals when the density is low [i.e., below ~1 cm^(-3)] or the temperature is high (i.e., Ti > ~100-200 eV, depending on the instrument). If we assume a bi-Maxwellian or even an isotropic Maxwellian, the peak phase space density goes as N*T^(-3/2). The one-count level during the same interval does not drop/change relative to an adjacent, earlier interval. Thus, the signal-to-noise ratio can drop preciptously during these periods. I realize this is an issue faced by all particle instruments, but it is worth discussing to ensure you do not lose the critical parts of the distribution downstream of strong shocks with high temperatures but relatively low density (e.g., for really low upstream density).

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Minor Concerns:

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-- Page 1, Lines 35-50: You could also mention waves and instabilities [e.g., Malaspina et al., 2013], as electromagnetic fluctuations are not solely limited to turbulence. It is also important to measure the full 3D VDFs for analysis of instabilities.

-- Page 2, Lines 2-18: The Wind spacecraft's 3DP instrument suite is also relevant here [e.g., Lin et al., 1995].

-- Page 2, Line 47: I know voxel is a term analogous to a velocity-space pixel, but could you provide a definition for the reader that may not know this.
-- Page 7, Lines 10-12: I am not sure I understand the sentence starting with "It starts measuring..." You state the instrument starts sampling at 600 ms and the duration required to obtain one full VDF is another 600 ms. Is that correct?

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Typos, Grammar, etc.:
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[The following are suggestions, not requirements (e.g., I do not recall rules for British vs. American grammar for when to use commas after things like "e.g." or "i.e.")]
Page 4, Line 25: "12, i.e. an order" --> "12, i.e., an order"
Page 5, Line 56: "i.e. one uses" --> "i.e., one uses"
Page 5, Lines 77-79: "In order to eliminate values that are completely off, a voting" --> "In order to eliminate outliers, a voting"
Page 5, Line 87: Try rephrasing the following "Note that such a more robust procedure requires" as it is awkwardly phrased and not clear what is meant.
Page 6, Line 38: "robust (i.e. when" --> "robust (i.e., when"
Page 6, Line 40: "...cient (i.e. when" --> "...cient (i.e., when"
Page 6, Line 98: "direction (i.e. with" --> "direction (i.e., with"
Page 8, Lines 62-63: "The measurement points" --> "The measurements"
Page 9, Line 19: "neither dramatic in magnitude nor very" --> "neither dramatic in magnitude or very"
Page 11, Line 5: "instrument (i.e. of" --> "instrument (i.e., of"
Page 14, Line 5: "manoeuvres" --> "maneuvers"

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