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Interactive comment on "A Comparison of Contact Charging and Impact Ionization in Low Velocity Impacts: Implications for Dust Detection in Space" *by* Tarjei Antonsen et al.

Anonymous Referee #1

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This paper describes a model for impact charge generation at slow speeds (< 10 km/s) that relies on contact charging through capacitive coupling. The results of this paper are novel and of substantial interest to the hypervelocity impact and cosmic dust detection communities, and introduces physics that were not previously captured by charge generation models based purely on shock induced ionization. The paper is generally well written and easily understood, with comparison to experimental results in literature that corroborate the model's validity over the impact parameters of interest.

However, I would like to suggest several revisions to clarify the derivation of the model and the uncertainties involved in the comparisons presented with respect to the shock

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ionization model and experimental results.

First, in Section 2.1, Equations 1 and 2 are stated to be from Wang and John (1988) but the equations do not appear in this form in the cited paper. Certain assumptions appear to be made implicitly, such as the Poisson's ratio needed for the relation between k_i and E_i, and the form of alpha appears to be inconsistent between Wang and John (where alpha should have units of length for aˆ2 = alpha * R) and this manuscript (where alpha should be dimensionless for A = alpha * pi * r_pˆ2). The derivation of Equation 2 from the model presented in Wang and John is not obvious and could use additional clarification.

Second, in Section 4.1, a comparison is made between the proposed contact charge model, the Drapatz and Michel model, and experimental results by Mocker et al. It is concerning that in Mocker's paper the Fe on Ag impacts for the charge production power law only included impacts greater than 4.7 km/s, but is extrapolated here in Figure 9 to less than 1 km/s to demonstrate where the Saha-Langmuir solution breaks down. While it is understandable that experimental data is limited, the manuscript should state more explicitly where assumptions are being made about the validity of extrapolated empirical laws, especially when the focus of the paper is on the transition to different physics becoming dominant at low impact speeds. Similarly, more detail on the MUDD measurements and the method used to produce the simulated results shown in Figure 7 would be of value in considering whether this model performs better than prior models such as Drapatz and Michel. Is the simulated current based on the overall dust density values, assuming an average impact rate? Or is it derived from a set of individual impact events?

If these two concerns are addressed, I believe that this paper would be worthy of prompt publication. However, in addition to the two prior concerns, there are a number of typographical errors and similar minor concerns that I enumerate below.

1) Page 2 line 22: At the end of Section 1, the outline should include a brief description

of Section 4.2 and possibly Section 5 for completeness.

2) Page 2 line 28/29: The motivation behind *the* model [...] the *critical* limit

3) Page 2 line 32: Should it say that "models such as shock wave ionization *underestimate* the produced charge"?

4) Page 3 line 26: only a small part of the projectile *contributes* to...

5) Page 4 line 2: Perhaps define MSP in 1st paragraph of Section 2.1 where meteoric smoke is first mentioned.

6) Equation 3: Define units, specify whether the distribution is cumulative

7) Page 4 line 15: More specifically, please specify "... use a packing efficiency value of 70%", and perhaps define the abbreviations used for the lattice structures

8) Page 4 line 18: ...as discussed in *Section 3*.

9) Page 5 line 1: Could the 5-10 factor be attributed to uncertainties/errors in the fill factor or other parameters, rather than only volume fraction contributing to the measured charge?

10) Figure 2: Size distribution of *parameterized* MSP particles

11) Page 6 line 11: The use of Z_e here for a length variable is confusing given the prior use of Z_tot for charge. Can a different letter be used for the separation distance?

12) Page 6 line 24: decreasing

13) Page 6 line 25: lowercase yield stress

14) Table 1: lowercase stainless steel, and please use a different abbreviation (maybe SS) to avoid ambiguity with the Saha-Langmuir solution later in the paper. SI prefixes could also be used in the 2nd and 3rd row headers for the table.

15) Page 7 line 18: Specify coulombs for |e|

16) Page 7 line 21: utilize

17) Page 8 line 1: ultimately

18) Page 8 line 12: the most widely cited velocity exponent is ...

19) Page 8 line 21: described

20) Page 8 line 25: we assume that the ice... (delete "for")

21) Page 8 line 29: may be motivated by the typical size...

22) Page 9 line 7 and 11: PAH and BCC have not been defined on first use

23) Page 10 line 16: the fragmentation model results *are*

24) Page 10 line 17: its value are two orders ... (delete "to")

25) Page 10 line 32: Perhaps include some discussion on the origin of pre-charge on particles in space and in an experimental facility

26) Figures 4-6: The use of a mass-specific unit on the left (C/kg) and absolute on the right (Z) is a bit confusing.

27) Page 13 line 21: shaded area shows values of (delete "a")

28) Page 16 line 21: The sentence here can be rephrased to read more clearly. Perhaps reverse the order to read "Assuming the particle has bulk properties, which is suitable [...], the available amount of substance [...] has a volume of [Equation 11]

29) Equation 12 and Page 16 line 28: Perhaps K should be italics (mathtype) to distinguish from K used for potassium

30) Figure 8: "the solid red line *shows*", and perhaps use a consistent colour scheme for traces derived from experimental results, black for contact charge model, etc.

31) Page 18 line 7: as *it* introduces

32) Page 19 line 12: Can the lower speed range of beta meteoroids be quantified here?

33) Page 20 line 15/16/19: Please be consistent with using ESO as the abbreviation after first use

34) Equation A3: Is the final term in the second summation correct here? It looks like the rˆ2 term might have been retained from the previous equality

25) Equation A5: Alpha has a dependence on (vˆ2)ˆ(2/5) - should the 4/15 here be 4/5?

26) A number of the references have a broken link with a duplicated URL header (the "https://doi.org" part)

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