Dear Editor:

We are very grateful for having received these most recent excellent comments and criticisms on our manuscript. We have combined our supplementary materials into appendices of the main text and have transferred our submission to Physical Review A. We have made some edits, summarized below, in response to our reviewers.

Sincerely,

David Reens, Hao Wu, Tim Langen, and Jun Ye

Referee Comments:

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Second Report of Referee A -- LF16145/Reens  
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*“The picture presented involves the idea of the length of the quantization axis which is unfamiliar to me and I think to most readers. For most, the term ‘quantization axis’ refers to the z-axis of the coordinate system in which a calculation is done. It does not have a length and is not a property of the molecule. “*

Our Response: We thank the reviewer for this great observation. Our understanding of the quantization axis as a property of the molecule evolved out of the interesting situation for dipolar molecules—namely that they have two possible quantization axes in mixed fields. We still believe that the quantization axis picture we present is a useful one, but we have addressed this by changing the way we refer to the quantization axis. We no longer discuss it as a property of the molecule, but only the choice between the two possible axes is a property of the molecule. We also no longer speak of the quantization axis as having a length, but only of an underlying vector field, which we now define clearly, as having said length: “The states of the molecule were shown to align with one of the two quantization axes set by the vector fields X⃗ ± = deffE⃗ ± μeffB⃗ [47], μeff and deff the effective dipole moments of the molecule in uncombined fields.”

*“I believe there is a clearer way to present the picture. In the preceding paragraph, the authors have already introduced the idea that both the magnetic and electric dipole moments are fixed to the internuclear axis. From the discussion of the trap geometry it is clear that there will be a plane where E is perpendicular to B. The internuclear axis will be aligned along E due to the strong interaction of the electric dipole with E, so the magnetic moment is perpendicular to B in this plane and there will be no Zeeman splitting. As a result, the spin is likely to flip when the molecule crosses this plane.”*

Our Response: We agree that this is a very elegant explanation, and an expedient way to arrive at the observation that plane crossings should lead to loss. One drawback however is that it appeals to the strength of the interaction of the electric dipole with E, which could make one assume that this is a perturbative argument, one that only applies for B << E. In fact, this is not the case. When the fields are orthogonal, the energy of states with alignment or antialignment with B are degenerate even for rather large values of B relative to E. In fact, in the limit of small lambda doubling, for arbitrary values of B. In the quantization axis approach, this result follows directly from the length degeneracy of the vector sum and vector difference of E and B when those fields are orthogonal.

One additional advantage of the quantization axis approach that we take here is that it exposes the problem from the point of view of an author or reader of Ref [47], which argues that the electric field vector ought to maintain a quantization axis and so prevent spin-flips. For now, we have left this quantization axis picture with the modifications described above, but if the reviewer prefers we should be happy to find a way to include their more elegant explanation.

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Second Report of Referee B -- LF16145/Reens  
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*“The paper is not easy to read! It is more prepared for experts who have a good background knowledge on the dynamics of particles moving in a magnetic and electric trap.”*

Our Response: We thank the reviewer for this frank and honest opinion. Unfortunately our decision to present our work more as an experimental demonstration of control over molecular spin flip loss than as an exciting next step of a plugged trap for further molecule cooling seems to have narrowed our audience. Perhaps now that we are targeting a more specialized journal, this is no longer a major drawback, but if the reviewer prefers I am sure we could find a way to use more guiding language and better organization with the general reader in mind.

*“It might help to reduce the technical information in Fig. 1 caption, but more about comparing the spin-flips of molecules in different trap geometries.”*

Our Response: We agree with this, and have addressed it by adding a summarizing sentence earlier on in the caption: “A uniform electric field, added to magnetically trapped molecules for dipolar studies or other purposes, enhances spin-flip losses. Note in particular the increased size of the lowest contour (red) in panel (f) relative to panel (e); this result can be understood by considering Zeeman shifts under various conditions as shown in panels (a-c) and described further now…”  
  
*“I consider suppressing or controlling the molecular spin flips is the main message of this paper. This is not very clear from the title. What does ‘... spin loss and ... trap’ mean? I would recommend something along the line of ‘Controlling spin-flips of ultracold molecules in an electro-magnetic trap’.”*

Our Response: Thank you for this excellent suggestion! We have made this change.