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6. AUTHOR(S) **Brian Hawkett**	5d. PROJECT NUMBER
	5e. TASK NUMBER
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14. ABSTRACT

During the first stage of the project we initially prepared a quantity of ionic liquid ferrofluid (ILFF) based on ethyl ammonium nitrate (EAN) for evaluation by the team at Michigan Tech. This ILFF proved to be too hydrophilic, too high in viscosity and lacking in physical robustness. As a consequence we prepared an ILFF based on EMIM-NTf2, which overcame these deficiencies. This required us to overcome the difficulties involved in taking a ferrofluid that was prepared and electrostatically stabilized in water and sterically stabilize it in a hydrophobic ionic liquid (IL). This ILFF performed well in tests done at Michigan Tech and is undergoing evaluation at the Air Force Research Laboratory at Kirtland AFB.

15. SUBJECT TERMS
Electric Propulsion, Ionic liquids

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05-09-2014	Final	6 Mar 2013 – 5 June 2014

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Prof Brian Hawkett

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a. REPORT	b. ABSTRACT	c. THIS PAGE			Ingrid J. Wysong, Ph.D.
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Final Report for AOARD Grant FA2386-13-1-4018

"Maximizing the Spiking Performance of ILFFs"

Date September 1st 2014

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Period of Performance: March/06/2013– June/05/2014

Abstract: During the first stage of the project we initially prepared a quantity of ionic liquid ferrofluid (ILFF) based on ethyl ammonium nitrate (EAN) for evaluation by Brad King's team at Michigan Tech. This ILFF proved to be too hydrophilic, too high in viscosity and lacking in physical robustness. As a consequence we prepared an ILFF based on EMIM-NTf2, which overcame these deficiencies. This required us to overcome the difficulties involved in taking a ferrofluid that was prepared and electrostatically stabilized in water and sterically stabilize it in a hydrophobic ionic liquid (IL). This ILFF performed well in tests done at Michigan Tech and is undergoing evaluation at the Air Force Research Laboratory at Kirtland AFB.

Overview: The aim of this project was to design an ILFF that was suitable for use in the space thruster designed by Brad King and his team at Michigan Tech. The project was successful in this regard. Our current project is designed to gain a better understanding of our product so that we can fine tune it for better performance. To the best of our knowledge our group is still the only group to have prepared a spiking ILFF based on a hydrophobic IL. Refer to referenced papers for details.

Papers published in peer-reviewed conference proceedings:

Kurt J. Terhune, Lyon B. King, Michael L. Hause, Benjamin D. Prince, Nirmesh Jain and Brian S. Hawkett. Species measurements in the beam of an ionic liquid ferrofluid electrospray source. American Institute of Aeronautics and Astronautics AIAA 2014-3694

Brandon A. Jackson, Lyon B. King, Nirmesh Jain and Brian S. Hawkett. Characterization of an Ionic Liquid Ferrofluid Electrospray Emission Pattern. American Institute of Aeronautics and Astronautics AIAA 2014-3539

Manuscripts submitted but not yet published:

Lyon B. King, Edmond Meyer, Mark A. Hopkins, Brian S. Hawkett, and Nirmesh Jain. Self-assembling array of magneto-electrostatic jets from the surface of a superparamagnetic ionic liquid. Submitted to Langmuir. Manuscript ID: la-2014-03341p

Interactions with industry or with Air Force Research Laboratory scientists or significant collaborations that resulted from this work:

An ILFF based on EMIM-NTf2 is currently being evaluated by Michael L. Hause and Benjamin Prince at the Air Force Research Laboratory, Kirtland AFB in conjunction with Brad King's team from Michigan Tech.