

Undergraduate Research Highlights

Gadea O, Blado G. Entropic Uncertainty Relations, Entanglement and Quantum Gravity Effects via the Generalized Uncertainty Principle. *Asian Journal of Research and Reviews in Physics (AJR2P)*. 2018; 1: 4: 1–12. doi: 10.9734/AJR2P/2018/44711 (Houston Baptist University)

We apply the generalized uncertainty principle (GUP) to the entropic uncertainty relation conditions on quantum entanglement. In particular, we study the GUP corrections to the Shannon entropic uncertainty condition for entanglement. We combine previous work on the Shannon entropy entanglement criterion for bipartite systems and the GUP corrections to the Shannon entropy for a single system to calculate the GUP correction for an entangled bipartite system. As in an earlier paper of the second author, which dealt with variance relations, it is shown that there is an increase in the upper bound for the entanglement condition upon the application of the generalized uncertainty principle. Necessary fundamental concepts of the generalized uncertainty principle, entanglement and the entropic uncertainty relations are also discussed. This paper puts together the concepts of entanglement, entropic uncertainty relations, and the generalized uncertainty principle, all of which have been separately discussed in pedagogical papers by Schroeder, Majernik et al., Blado et al., and Sprenger. Gardo Blado is a professor of physics at Houston Baptist University. At the time of the research, Otto Gadea was an undergraduate chemistry major with a minor in physics at Houston Baptist University. He started the research problem in spring 2017 and completed its solution in spring 2018. He voluntarily worked on the research problem to gain experience in theoretical research. Gadea completed his undergraduate degree in spring 2018 and is now a PhD student in the geophysics program at the University of Houston.

Amira K, Johnson LR, McCray D, Ragusa JM. Adversaries or Allies? Donald Trump's Republican Support in Congress. *Perspectives on Politics*. 2019; 17: 3: 756–771; doi: 10.1017/S1537592719001063 (College of Charleston)

Donald Trump's first year in office received unprecedented media coverage, with many wondering whether congressional Republicans were "adversaries" or "allies" of the president's legislative positions. Our paper explores this issue from two vantage points. First, we place Trump's presidency in historical context by forecasting his Republican support with data from 1969 to 2016. We find that Republicans supported Trump's legislative positions in 2017 at levels consistent with expectations, contrary to

the views of some. Second, we explore the factors that explain why Republican lawmakers supported or opposed their party's president. We find that conservative and establishment Republicans were more likely to support Trump, contrary to some claims, while female Republicans and those representing affluent, non-white districts were more likely to oppose Trump. Our paper concludes by discussing the broader implications of these results, including the role of identity in contemporary American politics and the possible realignment of the GOP. Karyn Amira is assistant professor and Jordan Ragusa is associate professor of political science at the College of Charleston (CofC). When the research began in winter 2018, Lauren Johnson and Deon McCray were undergraduates at CofC and worked on the project through independent studies. They have since graduated. Johnson lives in Des Moines and works with community organizations on local and state housing policy. McCray lives in Philadelphia and is planning to attend law school.

Andrews M, Smirnova A, Sharp D, Taylor S, Cobb J, Boucher D. Aggregate dispersions to enhance the intrachain order in surfactant-stabilized aqueous colloids of poly(3-hexylthiophene). *Journal of Molecular Liquids*. 2019; 277: 996-1004. doi: 10.1016/j.molliq.2019.01.031 (College of Charleston)

Aqueous colloids of conjugated polymers (CP), such as poly(3-hexylthiophene) (P3HT), are an attractive alternative for processing CP-based materials because (1) the microstructure of the conjugated polymers can be optimized during the formation of the colloid and (2) this method can significantly reduce the amount of hazardous organic solvents used during manufacturing. This investigation addresses the optimization of the polymer structure by studying the intrachain order of P3HT aggregates pre-assembled in mixtures of chloroform (CF) with dichloromethane (DCM) and subsequently dispersed in aqueous solutions of the surfactant sodium dodecyl sulfate (SDS) using a mini-emulsion method. Compared to an amorphous solution of P3HT, the observed intrachain order of P3HT in the colloids is much higher when using aggregate dispersions pre-assembled in the CF:DCM mixtures. Similar results are observed for aggregate dispersions of a benchmark organic photovoltaic system composed of P3HT and the fullerene derivative phenyl-C61-butyric acid methyl ester (PCBM), but in this case the intrachain order of P3HT in the P3HT:PCBM colloids is anomalously higher than the pure P3HT colloids. Atomic force microscopy (AFM) imaging reveals changes in the dominant structural

motifs and morphology of the colloidal P3HT films, but not in a way that correlates with films processed from the aggregate dispersions. David S. Boucher is associate professor in the Department of Chemistry and Biochemistry at the College of Charleston (CofC). McKenna Andrews worked on the research as a third-year student in a summer project at CofC, Devin Sharp worked on the research as a second-year student in a summer project at CofC, and Sarah Taylor worked on the research as a third-year student in a summer project at CofC, and John Cobb worked on the research as a second-year student in a summer project at CofC. At the time of the research, Anna Smirnova was a student at the Academic Magnet High School and worked on the research as an independent study project; she is currently attending Duke University. The work of Andrews, Sharp, Taylor, and Cobb was supported by the Petroleum Research Fund of the American Chemical Society (ACS-PRF [55397-UR7]); the work of Smirnova was supported by the Summer Research High School Experience of the Howard Hughes Medical Institute.

D'Souza MJ, Wirick J, Deol J, Kevill DN. Classical Tosylate/Chloride Leaving Group Approach Supports a Tetrahedral Transition State for Additions to Trigonal Carbon. *Trends in Organic Chemistry*. 2018; 19:1–11, PMID: PMC6366630 (Wesley College)

In chemistry, the dissolution process is important. Using concepts of leaving group effects, this project provides useful information to the dissolution processes of useful pharmaceutical and agricultural agents. Malcolm J. D'Souza is professor of chemistry and dean at Wesley College. Dennis N. Kevill is distinguished research professor emeritus of chemistry & biochemistry at Northern Illinois University. Jeremy Wirick (biological chemistry) and Jasbir Deol (biological chemistry) completed this Wesley College research project as part of a sponsored Directed Research Program in Chemistry. After graduation, Jeremy Wirick will enter the pharmacy program at University of North Carolina at Chapel Hill. Jasbir Deol currently is in her fourth year in Temple University's pharmacy program. The research was supported by an IDeA award (NIH-NIGMS P20GM103446, DE-INBRE); an NSF EPSCoR Grant IIA-1301765 (DE-EPSCoR); an NSF S-STEM Grant 1355554; the NASA Delaware Space Grant Consortium grant program (NNX15AI19H), and the State of Delaware.

Freeman L, Miller P, Sapolsky M, Boucher D. p-Doping Poly(3-hexylthiophene) in Solvent Mixtures. *Macromolecular Chemistry and Physics*. 2018; 219: 19: 1800146. doi: 10.1002/macp.201800146. (College of Charleston)

One method to improve the conductivity of conjugated polymers, like poly(3-hexylthiophene) (P3HT), is to

“chemically dope” them analogous to inorganic materials. One electron acceptor that has been used in tandem to p-doped P3HT is 2,3,5,6-tetrafluoro-7,7,8,8-tetracyanoquinodimethane (F4TCNQ), and recently there has been much interest in the nature of the interactions between F4TCNQ and P3HT in the solution phase. To date, however, there are few reports that investigate the behavior of F4TCNQ-doped P3HT in binary solvent mixtures. The study reported herein is an investigation of F4TCNQ-doped P3HT in mixtures of chloroform (CF) with dichloromethane (DCM) or acetonitrile (AcN), wherein variations in the doping efficiency in these mixtures are observed using UV–vis absorption, Raman, and electron paramagnetic resonance spectroscopic techniques. The contrasting solubility and charge transfer behavior of F4TCNQ-doped P3HT in CF:DCM and CF:AcN show that judicious selection of solvent mixtures may be exploited to improve the doping efficiency and solution processability of p-doped P3HT dispersions. David S. Boucher is associate professor in the Department of Chemistry and Biochemistry at the College of Charleston (CofC). Lucas Freeman and Paul Miller worked on the research as fourth-year students in a summer project at CofC and are currently in graduate school. Marni Sapolsky worked on the research as a fourth-year student in a summer project at CofC and is currently employed. The work of Freeman, Miller, and Sapolsky was supported by the Petroleum Research Fund of the American Chemical Society (ACS-PRF [55397-UR7]).

Sharp D, Taylor S, Andrews M, Boucher D. Impact of Varying Binary Solvent Gradients on the Solubility Parameters of Poly(3-hexylthiophene). *Macromolecular Chemistry and Physics*. 2019; 220: 1800406. doi: 10.1002/macp.201800406 (College of Charleston)

Current methods for estimating the solubility parameters (SPs) of a solute, particularly conjugated polymers and organic semiconductor moieties, suffer from theoretical and computational deficiencies that have led to many questions and investigations that seek improvement in solubility parameter theory. This investigation focuses on the variation of SPs of a prototype conjugated polymer, poly(3-hexylthiophene), using (1) different set of solvents and binary solvent mixtures having a broad range of chemical characteristics, and (2) multiple computational methodologies, for example, functional solubility parameter and Hansen solubility parameter approaches. The results reveal that the choice of solvents and the fitting methodology impact the empirical SPs when using the binary gradient method. The validity of the observed SPs and the relative contributions of the dispersion, polar, and hydrogen-bonding interactions are further rationalized using linear solvation energy relationship modeling of the solubility data. David S. Boucher is associate professor in the Department of Chemistry and Biochemistry at the College of Charleston

(CofC). Devin Sharp worked on the research as a second-year student in a summer project at CofC, Sarah Taylor worked on the research as a third-year student in a summer project at CofC, and McKenna Andrews worked on

the research as a third-year student in a summer project at CofC. The work of Sharp, Taylor, and Andrews was supported by the Petroleum Research Fund of the American Chemical Society (ACS-PRF [55397-UR7]).

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