COLLEGE OF CHARLESTON
FACULTY RESEARCH AND DEVELOPMENT COMMITTEE
GRANT APPLICATION COVER SHEET

(Deadlines are 5:00 pm on the dates shown below. Submit the complete grant application electronically to the Chair of the Faculty R & D Committee. Submit the cover sheet signed and dated to the Dean of the Graduate School by the 5:00 pm deadline.)

_____ First Round (10/04/13) __√__ Second Round* (01/17/14) _____ Third Round (04/05/14)

NAME: Iana Anguelova RANK: Assistant Professor

DEPARTMENT: Mathematics PHONE: 953-5651

PROPOSAL TITLE: Particle correspondences and combinations: field theory descriptions and mathematical identities

*In which fiscal year will your project take place? √ FY 13 - 14 √ FY 14 - 15

I am flexible, as I will be working on this research during all 10 of the Summer weeks.

Please refer to the Guidelines to insure that you comply with conditions for the category of award you seek. A copy of the guidelines may be found at the Faculty and Staff Resources link at http://gradschool.cofc.edu/facultystaff/researchanddevelopment/index.php

Which category of award do you seek? (Check one)

__√__ Faculty Research Grant _____ Faculty Development Grant _____ Faculty Professional Support

Check all sub-categories that apply.

__√__ Starter Grant (Check if the period of the grant is during your tenure-track appointment as a faculty member at the College of Charleston and your proposal meets the Starter Grant criteria.)

_____ Teacher-Scholar Grant (Check if your proposal meets the Teacher-Scholar Grant criteria.)

__√__ Continuous Study Award (Check if your proposal meets the Continuous Study Award criteria.)

Total Amount requested? $ 4000

Have you received Faculty R & D support for a funding period in the calendar year 2012? (Yes/No) _____ (If yes, list the amounts and dates in the spaces below)

Fiscal year 2011--2012: $ 4000

I received an R&D award in May-June 2012, which was more than 2 consecutive years from the current award period. I did NOT receive, nor applied, for an award in the year 2013.

Do you expect to receive funds from any other source for this project? (Yes/No) No **(If yes, list the sources(s) and amount(s) of the funding below)**

Does the proposal involve research on human or vertebrate animal subjects? (Yes/No) No
(If yes, include a brief statement describing the status of the Institutional Review Board (IRB) and/or Institutional Animal Care and Use Committee (IACUC) application. Such an approval must be obtained before research and development funds can be released.)

SIGNATURE, Applicant Iana Anguelova: Iana Anguelova [signature] Date 01/17/2014

Department Chair/Dean: Funds for successful proposals will be transferred into the departmental R & D account.

SIGNATURE, Department Chair/Dean [signature] Date 1/17/14

Starter Research Grant Proposal
Notes clarifying my Grant Application Cover Sheet

PARTICLE CORRESPONDENCES AND COMBINATIONS: FIELD THEORY DESCRIPTIONS AND MATHEMATICAL IDENTITIES

IANA I. ANGUELOVA

In which fiscal year will the project take place?

- FY 13–14
- FY 14–15

I marked both boxes, as indeed I will be working on this research continuously during the entire Summer of 2014, starting May 16 and finishing August 15. I have no preference as to the Fiscal Year, and if for budgetary reasons it is preferable that my project is substantially completed before June 30, then please consider a project starting date May 16, 2014, and ending June 30, 2014; thus entirely in Fiscal Year 2013–2014.

Award Sub-category

- Starter Grant
- Continuous Study Award

I marked both categories because my project falls into both categories. I am tenure-track (I do not yet have tenure), however I did receive previously an award of $4000 in the Fiscal Year 2011–2012. I consulted with the Chair of the Faculty Research and Development Committee, Professor William Scott Poole, who determined that I fall into the Starter Grant category. I will be working continuously all Summer on this project, therefore I fall into the Continuous Study Award category as well. Professor William Scott Poole asked me to write a short note clarifying my application, please contact me (email address anguelovai@cofc.edu) if there is a further clarification needed. Thank you for your consideration.

Starter Research Grant Proposal Summary

PARTICLE CORRESPONDENCES AND COMBINATIONS: FIELD THEORY DESCRIPTIONS AND MATHEMATICAL IDENTITIES

IANA I. ANGUELOVA

My research is in an area of Mathematics called Vertex Algebras, an area which deals with the mathematical description of quantum field theory. Quantum field theory is the theory that describes the "very small" –the physics of subatomic particles, such as the electron, the proton and the neutron. In quantum field theory the main objects of study are the so-called **fields**– each subatomic particle is described by its own "field". Thus, for example, the electrons are fields, and their antiparticles, the positrons (which have the same mass as electrons, but positive charge, hence the name), are fields. But also the force-carriers are fields: for example, the electromagnetic force between two electrons is caused by an exchange of photons, which too are fields (electromagnetic force is also what keeps the atom together). Even in the physics community quantum field theory is not a fully understood and clear-cut area, but in mathematics, where rigorous definitions and descriptions are the norm, the mathematical description of quantum field theory is in its infancy. In fact, even what exactly is a quantum "field" does not have a general mathematical definition. Many of the greatest mathematicians of the age are currently working on the rigorous mathematical descriptions of different sides and cases of quantum field theory (see for example [DE^+99]). Modeling a particle interaction or composition mathematically, besides giving a rigorous description, also provides **very rich mathematical structures** connecting different areas of mathematics, such as algebra and representation theory, integrable systems of differential equations and random matric theory, symmetric polynomials and combinatorics, number theory. In quantum field theory there are two types of particles: bosons and fermions. **Bosons** are subatomic particles that obey so-called Bose-Einstein statistics—their distinguishing feature being that several bosons can occupy the same "quantum state" (the name boson derives from the name of the physicist Satyendra Nath Bose.) On the other hand, **fermions**, named after physicist Enrico Fermi, obey Fermi -Dirac statistics, i.e., two or more fermions cannot occupy the same quantum state (this is called "Pauli exclusion principle"). Since bosons with the same energy can occupy the same place in space, bosons are often force carrier particles, for example the photon is the carrier of the electromagnetic force between two electrons. In contrast, fermions are usually associated with matter, for example the electron itself. There are cases where the bosons and the fermions are related by the **boson-fermion correspondences** (this was first discovered by the physicist T. Skyrme). In my research I study the rigorous mathematical description of these boson-fermion correspondences and other particle interactions and compositions. While the electron is an elementary particle itself, the proton and the neutron are particles which are not elementary: each is composed of three **quarks**. As opposed to the electron and the proton, quarks are particles with fractional charges. There are two parts to the research I propose to carry this summer: First, I propose to continue to study the mathematical properties of the new boson-fermion correspondence of type D-A ([Ang13]). In particular I intend to study the existence of conformal structures, as well as the representation theory results relating different Lie algebra modules described by this correspondence. Second, I propose to describe and study new particles correspondences and compositions and their mathematical descriptions, such as the field theory (vertex algebra) description of the quark decomposition of the proton and the neutron, as well as other quark combinations.

Budget

- Pay for the six weeks of continuous work on this project from 07/01/2014 to 08/15/2014. I request a salary support of $4000.

Note: I have no preference as to the Fiscal Year, as I will be working on this research during the entire Summer of 2014, starting May 16 and finishing August 15. If for budgetary reasons it is preferable that my project is substantially completed before June 30, then please consider a salary request starting May 16, 2014, and ending June 30, 2014.

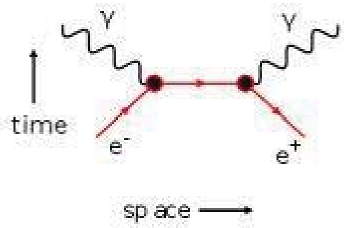
1. Project description

1.1. **Introduction: quantum field theory.**

Classical field theory describes well the mechanics of "everyday life". If we want to calculate the movement of an object, such as a stone thrown in the air, and if we know the initial position and the initial velocity of the object, we can find the solution to this problem– a specific function, describing what happens to the object: its trajectory and velocity, and anything else we may want to know. For example, if we throw a stone in a specific direction, we can calculate exactly where it is going to land. At each point of its trajectory we can also calculate the velocity of the stone at that point. This then is an example of a "classical field": the collection of all the velocities (vectors) along the trajectory of the object. One often sees such "classical fields" in weather forecasts–where the directions and speeds of the wind at different points are depicted by arrows (vectors) with labels on them. So in classical field theory, a classical "field" is just a type of a (vector) function of the space/time we are studying: to each point in space and time we assign a physical quantity. It is important that if we look at a specific space and time point of the trajectory, we **can** also measure (or calculate) the velocity (momentum) of the moving object at that point. That is how the weather forecasters can present to us the animated wind maps showing how the wind direction changes at different points as time passes. This is no longer possible in quantum mechanics—the mechanics of the very small, such as subatomic particles. In quantum mechanics we **cannot** know simultaneously the exact position **and** the exact velocity (momentum) of the particle (that is what the Heisenberg uncertainty principle says). In other words, weather forecasters trying to study a "quantum wind" would not be able to make an animation map of it at all! They can either know which point in space they are looking at and at what time, or they can know in which direction the wind is blowing there, but not both! That means that in the quantum world even the questions that can and should be asked change. A lot of the questions we asked in the classical world would have no meaningful answers in the quantum world at all. Take for example our stone-throwing situation: if we throw a "quantum stone" in a specific direction we may not know with certainty where it is going to land. I.e., it doesn't make sense to ask "what is the exact trajectory of a given particle", as we cannot ever know that with certainty. What we can ask is: what is the probability that the given particle will be in a specific "state". Thus the probabilities, or "expectation values" as they are called, of different states are some of the main objects of study in quantum field theory.

Quantum field theory is by its nature more complicated and thus much less understood than classical field theory. Even less so in mathematics (where rigorous definitions are the norm), than in physics, where one can at least rely on experimental measurements and observations for guidance. For example: what exactly do we mean by "state"? The answer is: depends on the situation; there are (somewhat ad-hoc) procedures, called quantizations, which translate different situations from classical to quantum field descriptions. (To be more technical, usually the "states" are elements of various Hilbert spaces.) What is a quantum field? In classical field theory, we were associating different physical **quantities** to points in space/time, but in quantum field theory this is no longer possible. So now instead of quantities we associate **quantum operators**. Unlike quantities, quantum operators **act** on a state and produce another state. For example the derivative we know from Calculus is one such quantum operator: it differentiates, or "acts", on a function and produces another function. (In quantum field theory the "momentum" operators are often derivatives.) The quantum fields then have to incorporate the information about the quantum operators and the states they act on, but also about the space and time. A quantum field theory is a theory that (for a particular situation) describes all the quantum states, their associated quantum fields, and the interactions between them. Conformal field theory is a special case of quantum field theory, where we have an additional special, "conformal", symmetry. Vertex algebras are the mathematical description of conformal field theory and are the primary object of study in this proposal.

1.2. **Quantum field theory, particle correspondences and mathematical structures.** Of particular interest to this project are certain field theory correspondences, such as the boson-fermion correspondences, and also more general particle correspondences and compositions. The boson-fermion correspondences model different cases of relations between the two fundamental types of particles: the bosons and the fermions. (Recall that bosons are particles such as the photons, several of which **can** occupy the same state; but fermions, such as the electron, **can not**). The boson-fermion (Bose-Fermi) correspondences are amazing phenomena incorporating very rich mathematical and theoretical physics structures in the intersection of several areas: algebra and representation theory, differential equations, symmetric polynomials and combinatorics, number theory, integrable models in statistical mechanics, conformal and quantum field theory. There are several known boson-fermion correspondences both in the mathematics as well as the physics literature. An unfortunate truth is that there is no known match-up between the mathematics and the physics descriptions of these correspondences, except for one. This single case can be described by the physics diagram ([Fey49]), depicting an electron e^- and a positron e^+ annihilating and producing two photons γ (i.e., a correspondence between two fermions and two bosons):



In the mathematics literature this correspondence is called "charged free boson-fermion correspondence", or "boson-fermion correspondence of type A" because its underlying symmetry algebra is of type A (see e.g. [Fre81], [DKM81], [KR87]). (There is a classification of the different symmetry algebras, or Lie algebras, which are labeled by the letters A, B, C, D, E, F and G). There are other boson-fermion and boson-boson correspondences in the mathematical literature, for example the boson-fermion correspondence of type B (introduced in [DJKM82], also [You89]), the boson-boson correspondence of type C ([DJKM81]), "super" versions and others. In [Ang13] (a paper which resulted from my previous College of Charleston R & D award) I introduced a new boson-fermion correspondence, of type D-A, which completed the bosonization of the cases where the underlying symmetry algebra is a double-infinite rank Lie algebra. Each such correspondence is a very important object of study, as each such correspondence gives rise to a great variety of mathematical formulas, as well as applications to such wide-ranging areas as representation theory, number theory, integrable systems, random processes, quantum field theory. Since the boson-fermion correspondence of type D-A is very new, many of the associated formulas and applications are just now being developed. The continuation of my research into its applications and the associated mathematical structures is the first part of my summer project.

A brief technical detour: I present here just an idea of the type of formulas, structures and applications which relate to the boson-fermion correspondence of type A, as the first part of this project will be to study the corresponding analogues for the correspondence of type D-A:

- Conformal structure: the correspondence of type A is an isomorphism of two conformal field theories (vertex algebras), i.e., it has a Virasoro structure. In particular, the correspondence of type A has a one-parameter family of Virasoro fields (see e.g. [Kac98]):

$$L^{A,\lambda}(z) = \frac{1}{2} :\alpha(z)^2: + (\frac{1}{2} - \lambda)\partial_z \alpha(z), \tag{1.1}$$

where $\alpha(z) =: \psi^+(z)\psi^-(z):$ is the Heisenberg field for the correspondence of type A. In physics language, one can identify the field $L^{A,\lambda}(z)$ as the energy-momentum tensor field. The presence of conformal structures in a given correspondence is very important to representation theory, as well as of course to conformal field theory.

- the Jacobi triple product identity

$$\prod_{j=1}^{\infty}(1-q^j)(1-zq^{j-1})(1-z^{-1}q^j)=\sum_{m\in\mathbb{Z}}(-z)^m q^{m(m-1)/2} \tag{1.2}$$

is obtained from counting and then equating the q-dimension of the underlying vector spaces on each of the bosonic and the fermionic sides ([Kac98]). It is an example of a character identity –this is the character denominator identity for the Kac-Moody algebra A_1^1 (hence the "type A" in the name of the correspondence).

End of technical detour.
What is amazing is not each single formula, equation or solution (although each is important), it is amazing that so many different mathematical ideas, formulas and structures result from a single boson-fermion correspondence.

2. Methods and goals of the project

There are three directions of research I plan to pursue in this project. The first direction is the most "applied", and concerns the mathematical applications and structures we get as a result of the new correspondence of type D-A introduced in [Ang13]. The second direction of research addresses the mathematical theory underpinnings of the variety of boson-fermion correspondences and more general particle correspondences and combinations. In particular, one needs to answer questions like: What, mathematically, **is** a boson-fermion correspondence? What is the vertex algebra description if such a correspondence, or of a given particle composition (such as three quarks combining to make another fermion like the proton)? The third direction addresses the question: are there other boson-fermion or particle correspondences? Do they fit the existing mathematical theories, or do they require more general mathematical description?

I already started obtaining some results for the boson-fermion correspondence of type D-A, which are parallels of the corresponding results for the boson-fermion correspondence of type A (see the technical detour). I am currently working on the existence of conformal structures in the correspondence of type D-A (the analogues of (1.1)), by using some of the tools developed in [Ang13] and [ACJ13]; this paper is in the preprint stage. Further, by using the methods of representation theory of infinite dimensional Lie algebras, we plan on working with my colleagues Elizabeth Jurisich and Ben Cox on a sequel paper to [ACJ13], regarding new representations of certain Kac-Moody algebras of type D obtained by using the correspondence of type D-A, and on the resulting character formulas (the analogues of (1.2)).

In [Ang13] we were able to answer some of the questions addressing the mathematical description of various correspondences, in particular the correspondences of types B, C and D-A. We used Hopf algebra theory to describe these correspondences as isomorphisms of twisted vertex algebras. In this summer's project I plan to use again Hopf algebra methods to study the field-theoretic mathematical description of certain particle configurations such as the proton and the neutron. Both the proton and the neutron are comprised of three quarks each, which implies that mathematically there is a correspondence which one could perhaps call a "quark-fermion" correspondence (in a similar, but also different, way to the boson-fermion correspondence of type A where two fermions annihilate to produce two bosons). This also ties in with the third direction of my research, namely the question of the existence of other particle correspondences. The answer to that is a qualified yes, as evidenced by other particle interactions such as the quark-antiquark annihilation, and the various quark combinations. I plan to continue my research on this topic during this summer.

3. Timetable, expected results and impact

3.1. **Timetable and expected results:** First, I plan to finish the paper "Boson-fermion correspondence of type D-A and conformal structures", and to present its results in the 30th International Colloquium on Group Theoretical Methods in Physics (to be held in Ghent, Belgium, in July 2014); as well as submit it for publication in the top-quality peer-reviewed journal "Letters in Mathematical Physics". Second, we plan to work during the summer with my colleagues Elizabeth Jurisich and Ben Cox on a sequel-paper to [ACJ13], which should be finished by August 15, 2014, and submit it for publication to another top-quality peer-reviewed journal, the Journal of Algebra. Further, in the end of July I plan to start working on a third paper, on the mathematical description of quantum field theory underlying the quark configurations of fermionic particles such as the proton and the neutron, with expected completion in the Fall 2014.

3.2. **Impact:** The mathematical descriptions of quantum field theory in general, and particle correspondences and combinations in particular, are hard subjects to study, but are also very beautiful, rich and interconnected, and this research will contribute to their development. Each single new particle correspondence enriches our understanding of this area. But also, it would be a major breakthrough if one can develop a categorical description which will allow us to deal with **all** the different correspondences from the same viewpoint. Discovering a structure underlying all the boson-fermion and particle correspondences and combinations may be far out of sight still, nevertheless I believe I can substantially further our understanding on this subject. I also hope this proposal will shed some understanding on the mathematical field theory (vertex algebra) description of quark configurations comprising non-elementary particles such as the proton and the neutron, an area of mathematics which is currently very underdeveloped.

3.3. **Current Support:** None. I have applied for an NSA Young Investigator Grant with a different, though related proposal, but it is for a starting date in the year 2015.

References

[Ang13] Iana I. Anguelova. Twisted vertex algebras, bicharacter construction and boson-fermion correspondences. *Journal of Mathematical Physics*, 54(12), 2013. 38pp.

[ACJ13] Iana I. Anguelova, Ben Cox, and Elizabeth Jurisich. Representations of a_∞ and d_∞ with central charge 1 on the single neutral fermion fock space $F^{\otimes \frac{1}{2}}$. *Journal of Physics: Conference Series*, 20pp., 474(1), 2013.

[DE+99] Deligne, Etingof, et al. Quantum fields and strings: A course for mathematicians. Vol. 1, 2. 1999. Providence, USA: AMS (1999) 1-1501.

[DJKM81] Etsurō Date, Michio Jimbo, Masaki Kashiwara, and Tetsuji Miwa. Transformation groups for soliton equations. VI. KP hierarchies of orthogonal and symplectic type. *J. Phys. Soc. Japan*, 50(11):3813–3818, 1981.

[DJKM82] Etsurō Date, Michio Jimbo, Masaki Kashiwara, and Tetsuji Miwa. Transformation groups for soliton equations. IV. A new hierarchy of soliton equations of KP-type. *Phys. D*, 4(3):343–365, 1981/82.

[DKM81] Etsurō Date, Masaki Kashiwara, and Tetsuji Miwa. Transformation groups for soliton equations. II. Vertex operators and τ functions. *Proc. Japan Acad. Ser. A Math. Sci.*, 57(8):387–392, 1981.

[Fey49] R. P. Feynman. The theory of positrons. *Phys. Rev.*, 76:749–759, 1949.

[Fre81] Igor B. Frenkel. Two constructions of affine Lie algebra representations and boson-fermion correspondence in quantum field theory. *J. Funct. Anal.*, 44(3):259–327, 1981.

[Kac98] Victor Kac. *Vertex algebras for beginners*, volume 10 of *University Lecture Series*. American Mathematical Society, Providence, RI, second edition, 1998.

[KR87] V. G. Kac and A. K. Raina. *Bombay lectures on highest weight representations of infinite-dimensional Lie algebras*, volume 2 of *Advanced Series in Mathematical Physics*. World Scientific Publishing Co. Inc., Teaneck, NJ, 1987.

[You89] Yuching You. Polynomial solutions of the BKP hierarchy and projective representations of symmetric groups. In *Infinite-dimensional Lie algebras and groups (Luminy-Marseille, 1988)*, volume 7 of *Adv. Ser. Math. Phys.*, pages 449–464. World Sci. Publ., Teaneck, NJ, 1989.

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Curriculum Vitae
Iana I. Anguelova

Current position: Assistant Professor, Department of Mathematics, College of Charleston

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Postal address, work:
College of Charleston
Math Department
66 George Street
Charleston, SC 29424

Work experience:

- Assistant Professor, Department of Mathematics, College of Charleston, SC, USA (August 2010–current)
- James H. Simons Instructor, Department of Mathematics, Stony Brook University, NY, USA (August 2008–August 2010)
- CRM Postdoctoral Fellow, Centre de Recherches Mathematiques (CRM), Montreal, Canada (June 2006–June 2008)
- Research Assistant Professor, Department of Mathematics, Concordia University, Canada (Sept. 2006–June 2008)

Education:

- PhD, Mathematics, University of Illinois at Urbana-Champaign (2006)

  Dissertation: Bicharacter Construction of Quantum Vertex Algebras

  Research Adviser: Prof. Maarten Bergvelt, Department of Mathematics, UIUC

- Coursework requirements for MSc/PhD in Department of Theoretical and Applied Mechanics (Spring 2004)
- MSc in Mathematics, University of Illinois at Urbana-Champaign (Fall 2002)
- Diploma for completed higher education, Department of Mathematics, Sofia University, Bulgaria (1996)

  Final year dissertation: Singular vectors in Verma modules over Virasoro algebra

  Specialization: Differential Equations

Academic research work experience:

- James H. Simons Instructor, Department of Mathematics, Stony Brook University (August 2008–August 2010)
- CRM Postdoctoral Fellow, CRM, Montreal (June 2006–June 2008)
- Research Assistant Professor, Mathematics, Concordia University (Sept. 2006–June 2008)
- Research Assistant, Theoretical and Applied Mechanics, UIUC (August 2002-August 2005)

  Research topic: *Asymptotic expansions of systems of differential equations around regular and irregular singular points, with application to detonation stability*

- Research Assistant, Theoretical and Applied Mechanics, UIUC (Spring 2002)

  Research topic: *Matched asymptotic expansions of systems of differential equations, with application to three-step chain-branching reaction*

- Research Assistant, Department of Mathematics, UIUC (Spring 2000, Fall 2002)

  Research topic: *Vertex algebras and soliton hierarchies*

Honors, fellowships and recognitions:

- James H. Simons Instructorship, Department of Mathematics, Stony Brook University (August 2008–August 2010)
- CRM Postdoctoral Fellowship (June 2006–June 2008)
- Fellowship, Department of Mathematics, UIUC (Spring 2004)
- Fellowship, Department of Mathematics, UIUC (Spring 2002)
- Teacher ranked as excellent by University of Illinois ICES score student evaluations (Fall 1999, Spring 2001, Fall 2001, Fall 2005, Spring 2006)

Teaching experience:

- Assistant Professor, Department of Mathematics, College of Charleston (August 2010–current)
- James H. Simons Instructor, Department of Mathematics, Stony Brook University (August 2008–August 2010)
- Research Faculty, Department of Mathematics and Statistics, Concordia University (Sept. 2006-June 2008)
- Teacher ranked as excellent by University of Illinois ICES score student evaluations (Fall 1999, Spring 2001, Fall 2001, Fall 2005, Spring 2006)
- Mentor, Department of Mathematics Peer TA Mentoring program, UIUC (Fall 2005, Spring 2006)
- Teaching Assistant, Department of Mathematics, UIUC (1999, 2000; 2001; Fall 2005, Spring 2006)
- Teaching Assistant, Department of Mathematics, Sofia University, Bulgaria (Spring 1996 - Spring 1999)
- Teaching Assistant, Department of Physics, Sofia University, Bulgaria (Spring 1996 - Spring 1999)

- Courses Taught:

MAT 323 Differential Equations	(College of Charleston)
MAT 104 Elementary Statistics	(College of Charleston)
MAT 207 Discrete Structures I	(College of Charleston)
MAT 103 Contemporary Mathematics with Applications	(College of Charleston)
MAT 315 Introduction to Complex Variables	(College of Charleston)
MAT 480 Topics in Applied Mathematics (Second Course in ODEs)	(College of Charleston)
MAT 305 Calculus IV (Differential Equations)	(SUNYSB)
MAT 303 Calculus IV with Applications (Introduction to Differential Equations)	(SUNYSB)
MAT 319 Fundamentals of Analysis	(SUNYSB)
MAT 205 Calculus III (Vector Calculus)	(SUNYSB)
Math 467 Measure Theory	(Concordia University)
Math 208 Fundamental Mathematics	(Concordia University)
Math 230 Second Course in Calculus and Analytic Geometry	(UIUC)
TAM 541 and 542 Math Methods for Engineers I and II (TA/subst. lecturer)	(UIUC)
Math 220 First Course in Calculus and Analytic Geometry	(UIUC)
Math 235 Accelerated Course in Calculus and Analytic Geometry	(UIUC)
Math 230 Second Course in Calculus and Analytic Geometry	(UIUC)
Math 442 Introduction to Partial Differential Equations (grader)	(UIUC)
Math 220 First Course in Calculus and Analytic Geometry (problem class leader)	(UIUC)

Publications and preprints:

1. M. Short, J. Bdzil, I. Anguelova, *Stability of CJ detonations for a stiffened gas model of condensed phase explosives*, Journal of Fluid Mechanics, 552 , 2006, 299 - 309

2. I. Anguelova, *Symmetric polynomials and H_D-quantum vertex algebras*, in "Lie algebras, Vertex algebras and their applications", Contemporary Mathematics 442, 2007, proceedings of the Conference in honor of J. Lepowsky and R. Wilson, 269-278.

3. I. Anguelova, *Bicharacter construction of quantum vertex algebras*, University of Illinois at Urbana-Champaign, 2006, PhD Thesis.

4. M. Short, I. Anguelova, T. Aslam, J. Bdzil, A. Henrick, G. Sharpe, *Stability of detonations for an idealized condensed state model*, Journal of Fluid Mechanics, 595, 2008, 45-82

5. I. Anguelova, *Super-bicharacter construction of quantum vertex algebras*, Reports in Mathematical Physics 61 (2008), no. 2, 253–263.

6. I. Anguelova. *Bosonization through super-bicharacter construction*, Proceedings of the 7th International Workshop "Lie Theory and Its Applications in Physics" (LT-7), 18-24 June 2007, Varna, Bulgaria.

7. I. Anguelova. *A note on quantum vertex operators and associativity*, J. Gen. Lie Theory Appl. 2 (2008), no. 3, 117–121

8. I. Anguelova, M. Bergvelt *H_D-quantum vertex algebras and bicharacters*, Communications in Contemporary Mathematics, 11 (2009), no. 6, 937–991.

9. I. Anguelova. *Boson-fermion correspondence of type B and twisted vertex algebras*, in "Lie Theory and Its Applications in Physics" (LT-9), Springer Proceedings in Mathematics and Statistics, vol. 36 (2013), 399-410.

10. I. Anguelova, M. Bergvelt, *Quadratic differential operators, bicharacters and $\bullet$ products* , 26pp., to appear in Communications in Algebra, arXiv:1109.1894v1 [math-ph], 2011–2013

11. I. Anguelova, *Twisted vertex algebras, bicharacter construction and boson-fermion correspondences*, 38pp., Journal of Mathematical Physics, 54(12), 2013.

12. I. Anguelova, Ben Cox, Elizabeth Jurisich, *N-point locality for vertex operators: normal ordered products, operator product expansions, twisted vertex algebras*, 38pp., to appear in Journal of Pure and Applied Algebra, 2013–2014.

13. I. Anguelova, Ben Cox, Elizabeth Jurisich, *Representations of a_∞ and d_∞ with central charge 1 on the single neutral fermion Fock space $F^{\otimes \frac{1}{2}}$*, 20pp., Journal of Physics: Conference Series, 474(1), 2013

14. I. Anguelova, *Virasoro structures in the twisted vertex algebras describing the boson-fermion correspondences of types B and C*, submitted

15. I. Anguelova, *Boson-fermion correspondence of type D-A and conformal structures*, in preparation

16. I. Anguelova, Ben Cox, Elizabeth Jurisich, *Kac-Moody algebra representations on the single neutral fermion Fock space $F^{\otimes \frac{1}{2}}$ and character identities*, in preparation

17. I. Anguelova, *Boson-fermion correspondences on Riemann surfaces*, in preparation

Selected Conferences:

- X International Workshop on Lie Theory and its Applications in Physics, Varna, Bulgaria

  Presentation: *Boson-Fermion Correspondences: Hopf algebra approach* (June 2013)

- Workshop on Integrable Systems and Quantum Symmetries, Prague, Czech Republic

  Presentation: *Boson-Fermion Correspondences: Hopf algebra approach* (June 2013)

- 2012 AMS Southeastern Section Meeting, Tampa, FL

  Presentation: $\mathbf{Z}_n$*-graded Hopf algebras, vertex algebras and particle correspondences* (March 2012)

- IX International Workshop on Lie Theory and its Applications in Physics, Varna, Bulgaria

  Presentation: *Boson-Fermion Correspondences and Twisted Vertex Algebras* (June 2011)

- 2011 AMS National Meeting, New Orleans, LA

  Presentation: *Bicharacter construction for the boson-fermion correspondences* (January 2011)

- Bifurcation Theory, Integrable Systems, and the Bispectral Problem, Sofia, Bulgaria

  Presentation: *Twisted and quantum vertex algebras via enhanced $(A; H; S)$ vertex algebras* (May 2010)

- Noncommutative Structures in Mathematics and Physics, Brussels, Belgium

  Presentation: *Quantum vertex algebras with Hopf symmetry* (July 2008)

- Algebra, Geometry and Mathematical Physics, Baltic-Nordic Workshop, Göteborg, Sweden

  Presentation: *Vertex algebras: from super to quantum* (October 2007)

- School and Workshop on Integrable Systems and Quantum Symmetries, Prague, Czech Republic

  Presentation: *Bicharacter construction for Deformed Chiral Super-Algebras* (June 2007)
- Short Program on Random Matrices, Random Processes and Integrable Systems (June-July 2005)

Selected seminar presentations:

- Geometry, Symmetry and Physics Seminar, Yale (March 2010)

  Twisted and quantum vertex algebras via enhanced (A, H, S) vertex algebras
- Algebra, Geometry and Physics Seminar, Stony Brook (March 2009)

  Bicharacter construction for (quantum) vertex algebras
- Infinite-Dimensional Algebra Seminar, MIT (December 2007)

  Quantum vertex algebras
- Algebra Seminar, Stockholm University, Sweden (October 2007)

  Vertex algebras: super, generalized and quantum
- Joint Mathematics and Physics Seminar, Chalmers, Sweden (December 2006)

  Bicharacter construction of deformed chiral algebras
- Mathematics Colloquium, Kansas State University (March 2006)

  (Quantum) Vertex Algebras and Symmetric Polynomials

Service:
Service to the Mathematics Profession:

- Referee for "Communications in Mathematical Physics", "Journal of Mathematical Physics", "Journal of Physics A, Mathematical and General"
- Organizer of the Seminar on Algebra and Mathematical Physics, College of Charleston
- Co-organizer of the Southeast Lie Theory Workshop, 2012, College of Charleston
- Organizer of the Seminar on Algebraic Methods in Statistical Mechanics, Stony Brook University
- Co-organizer of the Working Seminar on Integrable Systems, Random Matrices and Random Processes, Concordia University and CRM

Service to the College of Charleston:

- Member of the MES admissions committee (2010–current)
- Member of the Honor Board committee (2012–current)
- Member of the Honor Board Advisors committee (2012–2013)

Professional affiliation: American Mathematical Society

Citizenship: Bulgarian; US permanent resident

Languages: English (fluent), Bulgarian (native), Russian (fluent)