

Curriculum Vitae

SHRAWAN KUMAR

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Academic Qualifications:

B.Sc. Gorakhpur University 1973
M.Sc. Bombay University 1975
Ph.D. (Maths.) Bombay University 1986 (Thesis Adviser: S. Ramanan)

Positions :

1975-76, **Visiting Member**, Tata Institute of Fundamental Research (Bombay)
1976-82, **Research Assistant**, Tata Institute of Fundamental Research
1982-85, **Research Associate**, Tata Institute of Fundamental Research
Aug. 1983-July 84, **Postdoctoral Research Fellow**, Mathematical Sciences Research Institute (Berkeley)
July 1984-Aug. 85, **C.L.E. Moore Instructor**, Massachusetts Institute of Technology (Cambridge)
1985-89, **Fellow**, Tata Institute of Fundamental Research
Sept. 1988-May 89, **Member**, The Institute for Advanced Study (Princeton)
1989-92, **Reader**, Tata Institute of Fundamental Research
2006- , **Adjunct Professor**, Tata Institute of Fundamental Research
1991-2010 , **Professor**, University of North Carolina at Chapel Hill
2010- , **John R. and Louise S. Parker Distinguished Professor**, University of North Carolina at Chapel Hill

Visiting Positions :

- (1) Visiting Scholar at Massachusetts Institute of Technology (Cambridge) for two months April-May 1987
- (2) Visiting Professor at The University of British Columbia (Vancouver) for three weeks during June 1989
- (3) Visiting Professor at University of P. and M. Curie (Paris) for two weeks during May 1990
- (4) Visiting Professor at Scuola Normale Superiore, Pisa (Italy) for one month in May 1991 (to attend the International Semester on **Infinite dimensional algebra and algebraic geometry**).

- (5) Visiting Professor at Ecole Normale Supérieure (Paris) for two weeks during June 1991; three weeks during May-June 1992; one month during May 1994; and one month during May-June 1999
- (6) Visiting Professor at Max Planck Institut für Mathematik (Bonn) for one month during June-July 1993 and again for one week during July 2005
- (7) Visiting Professor at ICTP (Trieste) for one week during April 1994
- (8) Visiting Professor at Tata Institute of Fundamental Research (Bombay) for eight months during Dec. 1993-Aug. 1994; three weeks during July-Aug. 1995; six months from July 2001-Dec. 2001; ten days during January 2005; two weeks during December-January 2006-07; two weeks during December 2008; one week during December 2009; one week during May 2012; one week during December 2012; two weeks during December 2016 - January 2017; two weeks during January 2018; and one week during January 2019.
- (9) Visiting Professor at Research Institute for Mathematical Sciences, Kyoto University (Kyoto) for one month during June-July 1996
- (10) Visiting Professor at the Erwin Schrodinger International Institute for Mathematical Physics (Wien) for two weeks during August 2000
- (11) Senior Visiting Fellow at Isaac Newton Institute for Mathematical Sciences (Cambridge) for six months, January- June 2001
- (12) Visiting Professor at Weizmann Institute (Israel) for two weeks during June 2005
- (13) Visiting Professor at Duke University for one year, August 2006 -July 2007
- (14) Visiting Professor at the Hausdorff Research Institute for Mathematics, Bonn (Germany) for two weeks during January 2011 and for one month during April 2011.
- (15) Visiting Professor at the University of Aarhus, Aarhus (Denmark) for one week during July 2011.
- (16) Visiting Professor at the Harish-Chandra Research Institute, Allahabad (India) for one week during December 2013.
- (17) Visiting Professor at Institut Mittag-Leffler, Djursholm (Sweden) for one month during April - May, 2015 to participate in the 2015 Spring term research programme 'Representation Theory'.
- (18) Visiting Scholar at the University of Sydney, Sydney (Australia) for one semester, July 2015 - October 2015.

Honors and Awards :

- (1) Principal Investigator NSF grant no. DMS-9203660 for the period 1992-1995
- (2) Principal Investigator NSF grant no. DMS-9622887 for the period 1996-2000
- (3) Principal Investigator NSF grant no. DMS-0070679 for the period 2000-2005
- (4) Granted the W.N. Reynolds competitive leave of absence from the University of North Carolina at Chapel Hill for the period July 1-December 31, 2001
- (5) Principal Investigator NSF grant no. DMS-0401084 for the period 2004-2007
- (6) Principal Investigator FRG grant no. DMS-0554247 for the period 2006-2011 awarded by NSF (A collaborative grant between UNC, Chapel Hill; University of Maryland; and University of California, Davis)
- (7) Principal Investigator NSF grant no. DMS-0901239 for the period 2009-2012
- (8) Invited 45 minute speaker at the International Congress of Mathematicians (ICM), Aug. 2010 in the section 'Lie Theory and Generalisations'
- (9) Principal Investigator NSF grant no. DMS-1201310 for the period 2012-2015

- (10) Fellow of the American Mathematical Society (chosen in 2012)
- (11) Grant from the United States - Israel Binational Science Foundation (jointly with M. Gorelik, A. Joseph and V. Serganova) for the period 2014-2017.
- (12) Principal Investigator NSF grant no. DMS-1501094 for the period 2015-2018.
- (13) Principal Investigator NSF grant no. DMS-1802328 for the period 2018-2021.

Books Authored:

- (1) *Kac-Moody Groups, Their Flag Varieties and Representation Theory*, Progress in Mathematics vol. 204, Birkhäuser, Boston, 606 pages (Aug. 2002).
- (2) (jt. with M. Brion) *Frobenius Splitting Methods in Geometry and Representation Theory*, Progress in Mathematics vol. 231, Birkhäuser, Boston, 250 pages (Dec. 2004).
- (3) *Conformal Blocks, Generalized Theta Functions and the Verlinde Formula*, Cambridge University Press (New Mathematical Monograph series, volume 42) 536 pages (Jan. 2022).

List of Research Publications (all refereed):

- (1) A remark on universal connections. *Math. Ann.* 260, 453-462 (1982).
- (2) A G-minimal model for principal G-bundles. *Annales de L'Institut Fourier*, Grenoble 32, 205-219 (1982).
- (3) Geometry of Schubert cells and cohomology of Kac-Moody Lie algebras. *J. Diff. Geometry* 20, 389-431 (1984).
- (4) Rational homotopy theory of flag varieties associated to Kac-Moody groups. In: "Infinite dimensional groups with applications" (ed. by V. Kac). MSRI (Springer-Verlag) publications Vol. 4, 233-273 (1985).
- (5) Cohomology algebra of Schubert varieties associated to Kac-Moody groups. In: "Proceedings of the 1984 Vancouver Conference in Algebraic Geometry" (ed. by J. Carrell et. al.). CMS Conference Proceedings Vol. 6, 277-299 (1986).
- (6) A generalization of the Conner conjecture and topology of Stein spaces dominated by \mathcal{G}^n . *Topology* 25, 483-493 (1986).
- (7) (Jt. with B. Kostant) The nil Hecke ring and cohomology of G/P for a Kac-Moody group G. *Proc. Natl. Acad. Sci. USA* 83, 1543-1545 (1986).
- (8) A homology vanishing theorem for Kac-Moody algebras with coefficients in the category \mathcal{O} . *J. Algebra* 102, 444-462 (1986).
- (9) Non-representability of cohomology classes by bi-invariant forms (Gauge and Kac-Moody groups). *Commu. Math. Physics* 106, 177-181 (1986).
- (10) (Jt. with B. Kostant) The nil Hecke ring and cohomology of G/P for a Kac-Moody group G. *Advances in Math.* 62, 187-237 (1986).
- (11) (Jt. with B. Kostant) T-equivariant K-theory of generalized flag varieties. *Proc. Natl. Acad. Sci. USA* 84, 4351-4354 (1987).
- (12) Extension of the category \mathcal{O}^g and a vanishing theorem for the Ext functor for Kac-Moody algebras. *J. Algebra* 108, 472-491 (1987).
- (13) Demazure character formula in arbitrary Kac-Moody setting. *Invent. Math.* 89, 395-423 (1987).
- (14) Proof of the Parthasarathy-Ranga Rao-Varadarajan conjecture. *Invent. Math.* 93, 117-130 (1988).

- (15) Existence of certain components in the tensor product of two integrable highest weight modules for Kac-Moody algebras. In: "Infinite dimensional Lie algebras and groups" (ed. by V.G. Kac). Advanced series in Mathematical Physics Vol. 7, World Scientific, 25-38 (1989).
- (16) A refinement of the PRV conjecture. *Invent. Math.* 97, 305-311 (1989).
- (17) Bernstein-Gelfand-Gelfand resolution for arbitrary Kac-Moody algebras. *Math. Annalen* 286, 709-729 (1990).
- (18) (Jt. with K. Guruprasad) A new geometric invariant associated to the space of flat connections. *Compositio Math.* 73, 199-222 (1990).
- (19) (Jt. with B. Kostant) T-equivariant K-theory of generalized flag varieties. *J. Diff. Geometry* 32, 549-603 (1990).
- (20) Proof of Wahl's conjecture on surjectivity of the Gaussian map for flag varieties. In: "Algebraic groups" (ed. by S. Ramanan). Proceedings of the Hyderabad conference. Manoj Prakashan, 275-278 (1991).
- (21) (Jt. with B. Kostant) A geometric realization of minimal \mathfrak{k} -type of Harish-Chandra modules for complex s.s. groups. In: "Kazhdan-Lusztig theory and related topics" (ed. by V. Deodhar). Contemporary Mathematics vol. 139 published by AMS, 249-264 (1992).
- (22) Proof of Wahl's conjecture on surjectivity of the Gaussian map for flag varieties. *American J. of Math.* 114, 1201-1220 (1992).
- (23) (Jt. with V. Ginzburg) Cohomology of quantum groups at roots of unity. *Duke Math. J.* 69, 179-198 (1993).
- (24) Finiteness of local fundamental groups for quotients of affine varieties under reductive groups. *Comment. Math. Helvetici* 68, 209-215 (1993).
- (25) (Jt. with M. Vergne) Equivariant cohomology with generalized coefficients. *Astérisque* 215, 109-204 (1993).
- (26) Toward proof of Lusztig's conjecture concerning negative level representations of affine Lie algebras. *J. Algebra* 164, 515-527 (1994).
- (27) Symmetric and exterior powers of homogeneous vector bundles. *Math. Annalen* 299, 293-298 (1994).
- (28) Representations of quantum groups at roots of unity. In: "Quantum topology" (ed. by D.N. Yetter). World Scientific, Singapore, 187-224 (1994).
- (29) (Jt. with M. S. Narasimhan and A. Ramanathan) Infinite Grassmannians and moduli spaces of G -bundles. *Math. Annalen* 300, 41-75 (1994).
- (30) The nil Hecke ring and singularity of Schubert varieties. In: "Lie theory and geometry (in honor of B. Kostant)" (ed. by J.-L. Brylinski et. al.). Progress in Math. vol. 123, Birkhäuser, 497-507 (1994).
- (31) The nil Hecke ring and singularity of Schubert varieties. *Inventiones Math.* 123, 471-506 (1996).
- (32) (jt. with G. Letzter) Shapovalov determinant for restricted and quantized restricted enveloping algebras. *Pacific J. of Math.* 179, 123-161 (1997).
- (33) Infinite Grassmannians and moduli spaces of G -bundles. In: "Vector Bundles on Curves- New Directions," (ed. by M.S. Narasimhan). Springer Lecture Notes in Math. vol. 1649, 1-49 (1997).
- (34) (jt. with M.S. Narasimhan) Picard group of the moduli spaces of G -bundles. *Math. Annalen* 308, 155-173 (1997).

- (35) Fusion product of positive level representations and Lie algebra homology. In: “Geometry and physics” (ed. by J.E. Andersen et. al.). Lecture Notes in Pure and Applied Mathematics vol. 184, Marcel Dekker, Inc., 253-259 (1997).
- (36) (jt. with M.V. Nori) Positivity of the cup product in cohomology of flag varieties associated to Kac-Moody groups. *Inter. Math. Res. Not.* 14, 757-763 (1998).
- (37) (jt. with N. Lauritzen and J. Thomsen) Frobenius splitting of cotangent bundles of flag varieties. *Inventiones Math.* 136, 603–621 (1999).
- (38) Homology of certain truncated Lie algebras. In: “Recent Developments in Quantum Affine Algebras and Related Topics,” (ed. by K.C. Misra et. al.). *Contemporary Mathematics* vol. 248, 309–325 (1999), published by AMS.
- (39) (jt. with P. Littelmann) Frobenius splitting in characteristic zero and the quantum Frobenius map. *J. of Pure and applied Algebra* 152, 201–216 (2000).
- (40) (jt. with J.F. Thomsen) Frobenius splitting of Hilbert schemes of points on surfaces. *Math. Annalen* 319, 797–808 (2001).
- (41) (jt. with P. Littelmann) Algebraization of Frobenius splitting via quantum groups. *Annals of Mathematics* 155, 491–551 (2002).
- (42) (jt. with J.F. Thomsen) A conjectural generalization of the $n!$ result to arbitrary groups. *Transformation Groups* 8, 69–94 (2003).
- (43) Equivariant analogue of Grothendieck’s theorem for vector bundles on \mathbb{P}^1 . In: “Perspectives in Geometry and Representation Theory (A tribute to C.S. Seshadri),” Hindustan Book Agency, 500–501 (2003).
- (44) (jt. with B. Leeb and J. Millson) The generalized triangle inequalities for rank 3 symmetric spaces of noncompact type. *Contemporary Mathematics* vol. 332, published by AMS, 171–195 (2003).
- (45) (jt. with J.F. Thomsen) A new realization of the cohomology of Springer fibers. In: “Proceedings of the International Conference on Algebraic Groups and Arithmetic” (Volume dedicated to M.S. Raghunathan on his sixtieth birthday), Narosa Publishing House, 119–125 (2004).
- (46) Induction functor in noncommutative equivariant cohomology and Dirac cohomology. *J. Algebra* 291, 187–207 (2005).
- (47) (jt. with A. Boyzal) Explicit determination of the Picard group of moduli spaces of semistable G -bundles on curves. *Math. Annalen* 332, 823–842 (2005).
- (48) (jt. with K-H. Neeb) Extensions of algebraic groups. In: “Studies in Lie Theory” (Volume dedicated to A. Joseph on his sixtieth birthday), *Progress in Mathematics* vol. 243, Birkhäuser, 365–376 (2006).
- (49) (jt. with P. Belkale) Eigenvalue problem and a new product in cohomology of flag varieties. *Inventiones Math.* 166, 185–228 (2006).
- (50) (jt. with J. Stembridge) Special isogenies and tensor product multiplicities. *Inter. Math. Res. Not.* vol. 2007 (no. 20), 1–13 (2007).
- (51) On the Cachazo-Douglas-Seiberg-Witten conjecture for simple Lie algebras. *J. Am. Math. Soc.* 21, 797–808 (2008).
- (52) Descent of line bundles to GIT quotients of flag varieties by maximal torus. *Transformation Groups* 13, 757–771 (2008).
- (53) (jt. with W. Graham) On positivity in T -equivariant K -theory of flag varieties. *Inter. Math. Res. Not.* vol. 2008, 1–43 (August, 2008).
- (54) (jt. with M. Kapovich and J. Millson) The eigencone and saturation for Spin(8). *Pure and Applied Math. Quarterly* 5, 755–780 (2009).

- (55) (jt. with G. Lusztig and D. Prasad) Characters of simplylaced nonconnected groups versus characters of nonsimplylaced connected groups. *Contemporary Math.* vol. 478, 99–101 (2009).
- (56) (jt. with A. Boysal) A conjectural presentation of fusion algebras. *Advanced Studies in Pure Math.* vol. 54 (Algebraic Analysis and Around), 95–107 (2009).
- (57) (jt. with V. Mehta) Finiteness of the number of compatibly split subvarieties. *Inter. Math. Res. Not.* vol. 2009 (no. 19), 3595–3597 (2009).
- (58) (jt. with P. Belkale) Eigencone, saturation and Horn problems for symplectic and odd orthogonal groups. *J. Alg. Geom.* 19, 199–242 (2010).
- (59) A generalization of Cachazo-Douglas-Seiberg-Witten conjecture for symmetric spaces. *Math. Annalen* 346, 67–84 (2010).
- (60) (non-refereed article) Tensor product decomposition. *Proceedings of the International Congress of Mathematicians, Hyderabad, India*, pages 1226–1261 (2010).
- (61) (jt. with P. Belkale and N. Ressayre) A generalization of Fulton’s conjecture for arbitrary groups. *Math. Annalen* 354, 401–425 (2012).
- (62) (jt. with C. Procesi) An algebro-geometric realization of equivariant cohomology of some Springer fibers. *J. Algebra* 368, 70–74 (2012).
- (63) An approach towards the Kollár-Peskine problem via the instanton moduli space. ”Recent Developments in Lie Algebras, Groups, and Representation Theory”, PSPUM volume 86, 217–225 (2012).
- (64) (jt. with K. Schwede) Richardson varieties have Kawamata log terminal singularities. *Inter. Math. Res. Not.* vol. 2012 (issue 8), rns 241, 23 pages (2012).
- (65) Geometry of orbits of permanents and determinants. *Commentarii Math. Helv.* 88, 759–788 (2013).
- (66) (jt. with D. Prasad) Dimension of zero weight space: an algebro-geometric approach. *J. Algebra* 403, 324–344 (2014).
- (67) (jt. with N. Bushek) Hitchin’s conjecture for simply-laced Lie algebras implies that for any simple Lie algebra. *Diff. Geometry and its Applications* 35, 210–223 (2014).
- (68) (jt. with M. Brown) A study of saturated tensor cone for symmetrizable Kac-Moody algebras, *Math. Annalen* 360, 901–936 (2014).
- (69) A survey of the additive eigenvalue problem (with an appendix by M. Kapovich), *Transformation Groups* 19, 1051–1148 (2014).
- (70) A study of the representations supported by the orbit closure of the determinant, *Compositio Math.* 151, 292–312 (2015).
- (71) (jt. with J.M. Landsberg) Connections between conjectures of Alon-Tarsi, Hadamard-Howe, and integrals over the special unitary group, *Discrete Mathematics* 338, 1232–1238 (2015).
- (72) Additive eigenvalue problem, *EMS Newsletter*, December 2015, 20–27 (2015).
- (73) (jt. with P. Belkale) The multiplicative eigenvalue problem and deformed quantum cohomology. *Advances in Math.* 288, 1309–1359 (2016).
- (74) Representation ring of Levi subgroups versus cohomology ring of flag varieties, *Math. Annalen* 366, 395–415 (2016).
- (75) (jt. with R. Chirivì and A. Maffei) Components of $V(\rho) \otimes V(\rho)$, *Transformation Groups* 22, 645–650 (2017).
- (76) Positivity in T -equivariant K -theory of flag varieties associated to Kac-Moody groups (with an appendix by M. Kashiwara), *J. Eur. Math. Soc.* 19, 2469–2519 (2017).

- (77) (jt. with S. Baldwin) Positivity in T -equivariant K -theory of flag varieties associated to Kac-Moody groups II, Representation Theory (An electronic journal of the American Mathematical Society) 21, 35–60 (2017).
- (78) A complete set of intertwiners for arbitrary tensor product representations via current algebras, Transformation Groups 24, 115–125 (2019).
- (79) (jt. with S. Rogers) Representation ring of Levi subgroups versus cohomology ring of flag varieties II, J. of Algebra 556, 340–362 (2020).
- (80) (jt. with R. Rimanyi and A. Weber) Elliptic classes of Schubert varieties, Math. Annalen 378, 703–728 (2020).
- (81) (jt. with N. Ressayre) On the faces of the tensor cone of symmetrizable Kac-Moody Lie algebras, ArXiv:1902.02049, 52 pages (2019) (to appear in Annales Scientifiques de l'École Normale Supérieure).
- (82) (jt. with J. Hong) Conformal blocks for Galois covers of algebraic curves, ArXiv: 1807.00118v3, 72 pages (2021).
- (83) (jt. with S. Jeralds) Root components for tensor product of affine Kac-Moody Lie algebra modules, ArXiv:2106.11225, 35 pages (2021) (to appear in 'Representation Theory').
- (84) Subalgebra generated by ad-locally nilpotent elements of Borcherds Generalized Kac-Moody Lie algebras, J. of Algebra 594, 307–312 (2022).
- (85) (jt. with J. Hong) Conformal blocks for Galois covers of algebraic curves II, ArXiv: 2207.09578, 28 pages (2022).
- (86) (jt. with J. Xie) Representation ring of Levi subgroups versus cohomology ring of flag varieties III, ArXiv: 2207.04537, 28 pages (2022).
- (87) Category \mathcal{C}_k of multi-loop algebra representations versus modular representations: Questions of G. Lusztig, ArXiv: 2205.11556, 14 pages (2022).

Some Notable Invited Talks/Series of Lectures:

- (1) A series of eight lectures at the **C.I.M.E. session on “Vector bundles on curves. New directions”** held in Cetraro (Italy), June 1995.
- (2) An hour address at the **American Math Society spring sectional meeting** held at Davidson College, March 2007.
- (3) **CRM-University of Ottawa Distinguished Lecture** at the University of Ottawa, April 2007.
- (4) Gave a course consisting of 10 hours of lectures on ‘Demazure character formula in arbitrary Kac-Moody setting and its consequences’ at the **Taipei Winter School in Lie Theory** held in Taipei, December 2008.
- (5) Gave a course consisting of 10 hours of lectures on **Eigenvalue problem for reductive groups** at RIMS, Kyoto (Japan), May 2009.
- (6) Gave a course consisting of 4.5 hours of lectures on **Infinite Grassmannians, moduli spaces of G -bundles and Verlinde formula** at the University of Georgia, Athens (USA), VIGRE 2010 Summer School Workshop, May 2010.
- (7) Gave a course consisting of 2 hours of lectures on **Introduction to Frobenius splitting** at the ‘Frobenius Splitting in Algebraic Geometry, Commutative Algebra, and Representation Theory’ conference held at the University of Michigan, Ann Arbor (USA), May 2010.

- (8) Gave a course consisting of 10 hours of lectures on **Geometry of Schubert varieties and Demazure character formula** at the Hausdorff Research Institute for Mathematics, Bonn (Germany) during April 2011.
- (9) Gave an hour plenary address at the **DMV Annual Conference, 2011**, Cologne (Germany), September 2011.
- (10) Gave an hour **Spring 2012 Distinguished Lecture** at the University of Massachusetts, Amherst, February 2012.
- (11) Gave four hours' mini-course on **equivariant K -theory of flag varieties** at Jacobs University, Bremen (Germany), August 2012.
- (12) Gave four one and a half hours' mini-course on **Eigenvalue /Saturated Tensor Product Problem for Reductive Groups** at the University of Pisa, Pisa (Italy), June 2014.
- (13) Gave three two hours' mini-course on **Conformal blocks and Verlinde formula** at l'Université Claude Bernard Lyon 1, Lyon (France), June 2017.
- (14) Gave three one and a half hours' mini-course on **Space of Conformal Blocks and Proof of Verlinde Dimension Formula** at Tata Institute of Fundamental Research (Mumbai), January 2018.
- (15) Gave three one hour mini-course on **Littlewood-Richardson cone for symmetrizable Kac-Moody algebras** at Physikzentrum Bad Honnef (Germany) during the conference 'Geometry and Representation Theory of Algebraic Groups' celebrating the sixtieth birthday of F. Knop and P. Littelmann, March 2018.

Invited Talks: Gave the invited talks in the following conferences.

- (1) **Infinite dimensional groups with applications** held at MSRI, Berkeley (USA), May 1984.
- (2) **Algebraic geometry** held at The University of British Columbia, Vancouver (Canada), July 1984.
- (3) **Infinite dimensional Lie algebras and Lie groups** held at CIRM, Luminy (France), July 1988.
- (4) AMS meeting on **Infinite-dimensional symmetries in mathematics and physics** held in Worcester, MA (USA), April 1989.
- (5) AMS meeting on **Kazhdan-Lusztig theory and related topics** held in Chicago (USA), May 1989.
- (6) International conference on **Algebraic groups and applications** held at the University of Hyderabad (India), Dec. 1989.
- (7) **Enveloping algebras and rings of differential operators** held at Oberwolfach (Germany), April 1990.
- (8) Indo-USSR conference on **Geometry** held at T.I.F.R., Bombay (India), Jan. 1991.
- (9) The annual AMS meeting (**Quantum Groups** session) held in San Antonio, Texas (USA), Jan. 1993.
- (10) Symposium in honor of B. Kostant **Lie theory, algebra, and geometric quantization** held at M.I.T., Cambridge (USA), May 1993.
- (11) **Vector bundles on curves- New directions** held at T.I.F.R. (Bombay) and SPIC Science Foundation (Madras), Dec. 1993.
- (12) **Moduli spaces of semistable bundles over Riemann surfaces** held at University of Aarhus, Aarhus (Denmark), May 1995.

- (13) AMS meeting on **Quantum Kac-Moody Lie algebras and related topics** held in Greensboro, NC (USA), Nov. 1995.
- (14) **Schubert varieties; Geometry, algebra and combinatorics** held at Oberwolfach (Germany), April 1997.
- (15) **Algebraic and differential geometry** held at T.I.F.R. (Bombay), July 1997.
- (16) **Einhüllende algebren und darstellungstheorie** held at Oberwolfach (Germany), November 1997.
- (17) **Quantum groups and applications** held at Manhattan (Kansas), March 1998.
- (18) **Representations of affine and quantum affine algebras and related topics** held at NCSU, Raleigh, NC (USA), May 1998.
- (19) **Representation theory for algebraic groups and quantum groups** held at Aarhus (Denmark), August 1998.
- (20) **Enveloping algebras** held at The Weizmann Institute of Science, Rehovot (Israel), April 1999.
- (21) **Théorie des groupes** held at Institut de Mathématiques de Jussieu, Paris (France), June 1999.
- (22) **Workshop on nonabelian theta functions and moduli spaces of vector bundles** held in Salamanca (Spain), June 1999.
- (23) **Representations of algebraic groups** held in Luminy (France), November 1999.
- (24) **Mini-conference on Lie theory and geometry** held in Tucson (Arizona), December 1999.
- (25) **Algebraic groups and representation theory** held in Odense (Denmark), June 2000.
- (26) **Algebraic groups, invariant theory and applications** held in Wien (Austria), August 2000.
- (27) **Infinite dimensional Lie algebras and groups: Structure and geometry** held in Toronto (Canada), September 2000.
- (28) **Mini conference** held at Aarhus (Denmark), April 2001.
- (29) **Solstice d'ete on the theme 'Group Representations'** held in Paris (France), June 2001.
- (30) **International conference on representations of algebraic groups and quantum groups** held in Kunming (China), July 2001.
- (31) **International conference on algebraic groups and arithmetic** held in Mumbai (India), December 2001.
- (32) **Enveloping algebras and algebraic Lie representations** held at Oberwolfach (Germany), April-May 2002.
- (33) **International conference on Lie and Jordan algebras, their representations and applications** held at Guarujá, Sao Paulo (Brazil), May 2002.
- (34) **Algebraic transformation groups** held at Montreal (Canada), June 2002.
- (35) **A colloquium on geometry in honour of M.S. Narasimhan on the occasion of his 70th birthday** held at ICTP, Trieste (Italy), December 2002.
- (36) **Conference on representations of algebraic groups** held at Aarhus (Denmark), June 2003.
- (37) **Infinite dimensional Lie theory workshop** held in Toronto (Canada), July 2003.
- (38) **International colloquium on algebraic groups and homogeneous spaces** held in Mumbai (India), January 2004.
- (39) **Cohomological aspects of Hamiltonian group actions and toric varieties** held at Oberwolfach (Germany), April 2004.

- (40) **Infinite dimensional aspects of representation theory and applications** held at University of Virginia, Charlottesville (USA), May 2004.
- (41) **International conference on representation theory III** held at Sichuan University, Chengdu (China), August 2004.
- (42) **Interaction of finite dimensional algebras with other areas of mathematics** held at Banff International Research Station for Mathematical Innovation and Discovery (Canada), September 2004.
- (43) **Geometric representation theory** held at University of Arizona (USA), March 2005.
- (44) **Applications of torsors to Galois cohomology and Lie theory** held at Banff International Research Station for Mathematical Innovation and Discovery (Canada), April 2005.
- (45) **Algebraic combinatorics and geometry** held at University of Oregon (USA), November 2005.
- (46) **Lie algebras and representation theory**, American Math Society and Taiwanese Math Society joint meeting held at Tunghai University, Taichung (Taiwan), December 2005.
- (47) **Texas algebraic geometry seminar** held at Texas A and M University (USA), May 2006.
- (48) **Geometry and representation theory** (in honor of sixtieth birthday of G. Lusztig) held at MIT (USA), June 2006.
- (49) **Geometry and representations** held in Luminy (France), December 2006.
- (50) **Infinite dimensional Lie theory** held at Oberwolfach (Germany), December 2006.
- (51) **Algebraic groups** held at Oberwolfach (Germany), April 2007.
- (52) **Representations of algebraic groups and related topics** held in Bielefeld (Germany), April 2007.
- (53) **Algebraic analysis and around** (on the occasion of M. Kashiwara's sixtieth birthday) held at RIMS, Kyoto (Japan), June 2007.
- (54) **International conference on representation theory IV** held in Lhasa (Tibet), July 2007.
- (55) **B-stable ideals and nilpotent orbits** held at Istituto Nazionale di Alta Matematica, Rome (Italy), October 2007.
- (56) **Transformation Groups** (on the occasion of E. Vinberg's seventieth birthday) held at the Independent University of Moscow, Moscow (Russia), December 2007.
- (57) **John Millson 62: Lie theory, geometry, and discrete groups** held at University of Maryland, College Park, March 2008.
- (58) **AMS - SBM joint international meeting** held at IMPA, Rio de Janeiro (Brazil), June 2008.
- (59) **Conference on vector bundles in honour of S. Ramanan** (on the occasion of his seventieth birthday) held in Madrid (Spain), June 2008.
- (60) AMS meeting on **Kac-Moody algebras, vertex algebras, quantum groups, and applications** held at NCSU, Raleigh, April 2009.
- (61) **Eigenvalue and saturation problems for reductive groups** held at the University of North Carolina, Chapel Hill, May 2009.
- (62) **Representation theory** held at the University of Utah, Salt Lake City, July 2009.
- (63) **Lie algebras, vertex algebras and automorphic forms** held at ICMS, Edinburgh (Scotland), September 2009.

- (64) **CBMS conference on quiver varieties and quantum affine algebras** held at NCSU, Raleigh, May 2010.
- (65) **MAA Mathfest conference on combinatorial games and Schubert calculus** held in Pittsburgh, PA, August 2010.
- (66) **Infinite dimensional Lie theory** held at Oberwolfach (Germany), November 2010.
- (67) **UW-UBC algebraic geometry seminar** held at University of British Columbia (Vancouver), March 2011.
- (68) **The third SE Lie theory workshop** held at University of Virginia, Charlottesville (USA), June 2011.
- (69) **Mathematical aspects of P versus NP and its variants** held at ICERM (Providence), August 2011.
- (70) **First Latin American school on algebraic geometry** held in La Cumbre, Cordoba (Argentina), August 2011.
- (71) **DMV Annual Conference, Algebra Section** held in Cologne (Germany), September 2011.
- (72) **Geometry and representation theory related to geometric complexity and other variants of P v. NP** held at Snowbird, Utah, June 2012.
- (73) **Geometric and Algebraic Aspects of Representation Theory**, AMS Southeastern Fall Section Meeting held in New Orleans (USA), October 2012.
- (74) **International Conference on Algebraic Geometry in honor of Prof. M.S. Narasimhan's eightieth birthday** held in Bangalore (India), December 2012.
- (75) **AMS Special Session on Geometric Complexity Theory (a MRC Session)**, Joint Mathematics Meetings held in San Diego, January 2013.
- (76) **Algebraic groups** held at Oberwolfach (Germany), April 2013.
- (77) **Algebra, Geometry and Combinatorics Day** at IUPUI, Indianapolis, April 2013.
- (78) **The Third International Symposium on Groups, Algebras and related topics** celebrating the 50th anniversary of the Journal of Algebra held at the Peking University, Beijing, June 2013.
- (79) **The 6th International Conference on Representation Theory (ICRT-VI)** held in Zhangjiajie (Hunan Province, China), June 2013.
- (80) Plenary talk in the conference **Differential Geometry and its Applications** held in Brno (Czech Republic), August 2013.
- (81) **Representations of Lie algebras and Lie superalgebras** held at the University of Georgia, Athens, May 2014.
- (82) **Representation theory of algebraic groups** held at the Universite de Lyon, Lyon (France), July 2014.
- (83) **Representations of algebraic groups and related objects** held at Friedrich-Schiller-University, Jena (Germany), September 2014.
- (84) **Geometric Complexity Theory** held at the Simons Institute for the Theory of Computing, Berkeley, September 2014.
- (85) **Aspects of Lie Theory** held at the Istituto Nazionale di Alta Matematica, Rome (Italy), January 2015.
- (86) **Representation Theory Workshop** held at Uppsala University, Uppsala (Sweden), May 2015.
- (87) **Enveloping Algebras and Geometric Representation Theory** held at Oberwolfach (Germany), May 2015.
- (88) **Representation Theory and Algebraic Geometry (special session of the 2015 AustMS Conference)** held at Flinders University (Australia), September 2015.

- (89) **Taipei Conference in Representation Theory V (dedicated to George Lusztig on the occasion of his 70th birthday)** held at Institute of Math, Academia Sinica, Taipei (Taiwan), January 2016.
- (90) **Texas A&M Regional Conference** held at Texas A&M (Texas), November 2016.
- (91) **Algebraic Groups, TIMC-AMS Conference** held in Benares, India, December 2016.
- (92) **Algebraic Groups** held at Oberwolfach (Germany), April 2017.
- (93) **Algèbre, Rencontres Grenoble/Lyon/Saint-Étienne** held in Lyon, France, June 2017.
- (94) **Algebraic Modes of Representations - The Canicular Days** held at the Weizmann Institute, Rehovot, Israel, July 2017.
- (95) **Representation Theory, Geometry, and Quantization: the mathematical legacy of Bertram Kostant** held at MIT, May 2018.
- (96) **Interactions of Quantum Affine Algebras with Cluster Algebras, Current Algebras and Categorification (in honor of V. Chari's 60th Birthday)** held at the Catholic University of America, Washington D.C., June 2018.
- (97) **Geometric Quantization and Applications** held at CIRM, Luminy, France, October 2018.
- (98) **Algebraic Groups: Geometry, Actions and Structure (Dedicated to M. Brion on his 60th birthday)** held at Université Claude Bernard, Lyon, France, October-November 2018.
- (99) **Enveloping Algebras and Geometric Representation Theory** held at Oberwolfach (Germany), November 2018.
- (100) **Conference in Geometry and Representations (in celebration of W. Haboush's 75th birthday)** held in Jeju Island, South Korea, January 2019.
- (101) **Affine Flags, Folded Galleries and Euclidean Reflection Groups** held at University of Sydney, August 2019.
- (102) **Degeneracy Loci and Applications** held at Ohio State University, Columbus but via Zoom, May 2021.
- (103) **Quantum Fields, Geometry and Representation Theory 2021**, Online Conference organized by the 'International Centre for Theoretical Sciences of the Tata Institute of Fundamental Research (ICTS-TIFR)', Bangalore, July 2021.

Professional Services

- (1) Coorganizer for the International conference on **Algebraic groups and applications** held at the University of Hyderabad (India), Dec. 1989.
- (2) Served as an editor in the journal "Communications in Algebra", for the period Jan. 1990- Dec. 94.
- (3) Coorganizer for the Indo-USSR conference on **Geometry** held at T.I.F.R., Bombay (India), Jan. 1991.
- (4) Coorganizer for the Symposium in honor of B. Kostant **Lie theory, algebra, and geometric quantization** held at M.I.T., Cambridge (USA), May 1993.
- (5) Reviewer for Zentralblatt für Mathematik.
- (6) Member of the editorial board for the Lecture note series PRAVESHKA published by the National Board of Higher Mathematics, India.
- (7) Coorganizer for the conference on **Algebraic and differential geometry** held in July 1997 in Bombay.

- (8) Member of the editorial board of the journal “Transformation Groups” since 1998.
- (9) Director of Graduate Studies, UNC at Chapel Hill, July 1997- June 2000.
- (10) Member of the editorial board of the ‘Advanced texts in mathematics’ series of Birkhauser, 2001- -.
- (11) Member of the editorial board for the publication of ‘Collected papers of B. Kostant’ to be published by Springer-Verlag.
- (12) Member of the UNC Math Department Advisory Committee (an elected body), 2003- 2006.
- (13) Coorganizer for the meeting on **Enveloping algebras and geometric representation theory** held at Oberwolfach (Germany), March 2005.
- (14) Coorganizer for the meeting on **Applications of torsors to Galois cohomology and Lie theory** held at Banff International Research Station for Mathematical Innovation and Discovery (Canada), April 2005.
- (15) Served on the review panel of **Science Foundation Ireland**, November 2006 and again March 2007.
- (16) Coorganizer for the meeting on **Lie theory and geometry: the mathematical legacy of Bertram Kostant** held at the Pacific Institute of Mathematical Sciences, Vancouver (Canada), May 2008.
- (17) Coorganizer for the meeting on **Enveloping algebras and geometric representation theory** held at Oberwolfach (Germany), March 2009.
- (18) Coorganizer for the meeting on **Eigenvalue and saturation problems for reductive groups** held at UNC, Chapel Hill, May 2009.
- (19) Served on the NSF Career Core panel, October 2009; NSF review panel, February 2017.
- (20) Coorganizer for the meeting on **Frobenius splitting in algebraic geometry, commutative algebra, and representation theory** held at the University of Michigan, Ann Arbor, May 2010.
- (21) Member of the editorial board of the journal “Journal of Algebra” July 2010 – January 2018.
- (22) Coorganizer for the meeting on **Enveloping algebras and geometric representation theory** held at Oberwolfach (Germany), March 2012.
- (23) Coorganizer for the MRC summer conference on **Geometry and representation theory related to geometric complexity and other variants of P v. NP** held at Snowbird, Utah, June 2012.
- (24) Director of Graduate Studies, UNC at Chapel Hill, July 2011- June 2012.
- (25) Member of the editorial board of ‘Journal of the Ramanujan Math Society’, 2014 - -.
- (26) Coorganizer for the **Workshop on Moduli Spaces, Derived Geometry, and Geometric Representation Theory** held at UNC, Chapel Hill, November 2014.
- (27) Coorganizer for the **AMS Sectional Meeting (special Session on Lie Theory, Representation Theory, and Geometry)** held at University of Georgia, Athens (GA), March 2016.
- (28) Coorganizer for the **AMS Sectional Meeting (special Session on Algebraic Geometry, Representation Theory, and Applications)** held at Vanderbilt University, Nashville (TN), April 2018.
- (29) Coorganizer for the meeting on **Representation Theory, Geometry, and Quantization: The Mathematical Legacy of Bertram Kostant** held at the Massachusetts Institute of Technology, Cambridge (MA), May 2018.

- (30) Coorganizer for the **AMS Sectional Meeting (special Session on Geometric Methods in Representation Theory)** held at Auburn University, Auburn (AL), March 2019.
- (31) Associate Chair, Department of Mathematics, UNC, July 2016 - June 2019 and July 2020 - June 2021.
- (32) Editor for the memorial article "Remembering M.S. Narasimhan (1932 – 2021)" to appear in the Notices of the American Mathematical Society (Aug., 2022).

Students Completed Ph. D. Under My Supervision

- (1) David W. Lyons (Fall, 1996)
- (2) Richard H. Hammack (Fall, 1996)
- (3) S. Ilangoan (Fall, 1998)
- (4) Shawn Robinson (Spring, 2001)
- (5) Arzu Boysal (Spring, 2005)
- (6) Charles Hague (Summer, 2007)
- (7) Brandyn Lee (Spring, 2012)
- (8) Merrick Brown (Summer, 2014)
- (9) Nathaniel Bushek (Spring, 2015)
- (10) Seth Baldwin (Spring, 2018)
- (11) Sean Rogers (Fall, 2018)
- (12) Samuel Jeralds (Spring, 2021)
- (13) Jiale Xie (Spring, 2022)

Students Completed M. S. Under My Supervision

- (1) Swarnava Mukhopadhyay (Spring, 2010)