Sri Rama Koti Ainavarapu, PhD

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Education & Research Training

MSc (Chemistry) in 1997 from University of Hyderabad, Hyderabad
PhD in Physical Chemistry in 2002 from Tata Institute of fundamental Research, Mumbai
Post-doctoral research scientist (2003-2007), Columbia University, New York, USA

Professional Experience

January 2014 – present: Associate Professor (G), Department of Chemical Sciences, TIFR
Feb 2008 – Dec 2013: Reader (F), Department of Chemical Sciences, TIFR

Research Interests:

Our laboratory uses a combination of experimental, theoretical and computational tools (*Protein engineering, polymer synthesis, fluorescence spectroscopy, single-molecule atomic force microscope (SM-AFM), theoretical methods and steered molecular dynamics (SMD)*) to probe the stability and dynamics of proteins and polymers. Using SM-AFM and SMD, we probe the mechanical response of proteins and synthetic polymers. Some of the projects that are currently being pursued in our laboratory are:

- Experimental characterization of the mechanical unfolding pathways of large multi-domain proteins (e.g. maltose binding protein (MBP), leucine binding protein (LBP) and ribose binding protein (RBP)) that have implications in *in vivo* protein unraveling and translocation across the bacterial periplasmic membrane.
- Mechanical unfolding of proteins with very high structural homology but little sequence homology to elucidate the relation of protein structure with protein stability and function (e.g., comparing mechanical properties of Ubiquitin with SUMO proteins).
- Investigations on the molecular basis of Malaria – using *Plasmodium falciparum* spozoites and their surface proteins – circumsporozoite protein (CSP) and NANP-repeats.
- Investigations on the mechanical behavior and functional role of cell-surface protein receptors (e.g., CD4) and lamin proteins forming the fibrillar network in the nucleus (nuclear lamina).
- The role of metal ions (Ca^{2+}, Cu^{2+}, etc.) in stability and function of metalloenzymes.
- Synthesis of PPV (polyphenylenevinylene) based polymers to insert mechano-sensitive chemical bonds to study their force-dependent chemistry using SM-AFM.
- Synthesis of GFP (green fluorescent protein) oligomers with novel cross-linkages and their characterization using fluorescence spectroscopy (anisotropy and homoFRET).

Seminars/Conferences/Organizing committee:

Seminars: Approx. 50 Seminars (invited talks in conferences, workshops, etc.) given since 2007.

Organizer: "OWLS 2016: Optics Within Life Sciences", at TIFR, Mumbai, India; "Fluorescence 2009: an international conference of fluorescence techniques in biology", at TIFR, Mumbai, India; Biophysics Paschim V (2013) at TIFR, Mumbai, India

Organizing committee: Since 2010, I have been involved in co-organizing one-week annual workshops in India on spectroscopy and other advanced experimental single-molecule techniques.

Research Publications: ***(~60 Publications with ~1950 citations, h-index 22, i10-index 27)***

Google Scholar: https://scholar.google.co.in/citations?hl=en&user=bjC2SH8AAAAJ

(Author's name is printed as "A.S.R.Koti" in publications prior to 2004 and as "Sri Rama Koti Ainavarapu" in later publications)

In peer-reviewed international journals:

1. S. Bhattacharyya and Sri Rama Koti Ainavarapu*, Mechanical Softening of a Small Ubiquitin-related Modifier Protein (SUMO2) Due to Temperature Induced Flexibility at the Core, ***J. Phys. Chem. B*** (2018). In Press.
2. Anju Yadav, Sanjoy Paul, Ravindra Venkatramani*, and Sri Rama Koti Ainvarapu*, Differences in the mechanical unfolding pathways of apo- and copper-bound azurins, ***Scientific Reports,*** Vol. 8 (2018), 1989.
3. Aditya P. Patra, Shobhona Sharma, and Sri Rama Koti Ainavarapu*, Force spectroscopy of the *Plasmodium falciparum* vaccine candidate circumsporozoite protein suggests a mechanically pliable repeat region, ***J. Biol. Chem.***, Vol. 292 (2017) p2110-2119.
4. Hema Chandra Kotamarthi* and Sri Rama Koti Ainavarapu, Mechanical Unfolding Studies on Single-Domain SUMO and Multi-Domain Periplasmic Binding Proteins, ***Biophys. Rev. Lett.***, Vol. 12 (2017) p1-10.
5. Manindra Bera, Sri Rama Koti Ainavarapu, and Kaushik Sengupta*, Significance of 1B and 2B domains in modulating elastic properties of lamin A, ***Scientific Reports,*** Vol. 6 (2016), 278279.
6. Hema Chandra Kotamarthi, Anju Yadav, and Sri Rama Koti Ainavarapu*, Small peptide binding stiffens the ubiquitin-like protein – SUMO1, ***Biophysical Journal,*** Vol. 108 (2015), p360-367.
7. Manindra Bera, Hema Chandra Kotamarthi, Subarna Dutta, Angana Ray, Saptaparni Ghosh, Dhananjay Bhattacharyya, Sri Rama Koti Ainavarapu, and Kaushik Sengupta*, Characterization of unfolding mechanism of human lamin A Ig fold by single-molecule force spectroscopy – implications in EDMD, ***Biochemistry,*** Vol. 53 (2014), p7247-7258.
8. Hema Chandra Kotamarthi, Satya Narayan, and Sri Rama Koti Ainavarapu*, Mechanical Unfolding of Ribose Binding Protein (RBP) and Its Comparison with Other Periplasmic Binding Proteins (PBPs), ***J. Phys. Chem. B,*** Vol. 118 (2014), p11449-11454.
9. Venkatraman Ramanujam, Hema Chandra Kotamarthi, Sri Rama Koti Ainavarapu*, Ca^{2+} binding enhanced mechanical stability of an archaeal crystallin, ***PLOS ONE,*** Vol. 9 (2014) e94513.
10. Vijay Kumar Ravi, Mohit Goel, Hema Chandra Kotamarthi, Sri Rama Koti Ainavarapu, and Rajaram Swaminathan*, Preventing Disulphide Bond Formation Weakens Non-covalent Forces Among Lysozyme Aggregates, ***PLOS ONE,*** Vol. 9 (2014) e87012.
11. Hema Chandra Kotamarthi, Riddhi Sharma, Satya Narayan, Sayoni Ray, and Sri Rama Koti Ainavarapu*, Multiple unfolding pathways of leucine binding protein (LBP) probed by single-molecule force spectroscopy (SMFS), ***J. Am. Chem. Soc.,*** Vol. 135 (2013) p14768-14774.
    - This publication has been highlighted in "Spotlights on Recent JACS Publications", ***J. Am. Chem. Soc.,*** **2013**, Vol. 135, p15269, under the title "**PULLING ON A PROTEIN TO MAP ITS UNFOLDING PATHWAYS"**.
    - This article is highlighted in **'JACS Editorial on 'Protein Dynamics in Simulation and Experiment', *J. Am. Chem. Soc.*, 2014**, Vol. 136, p16695.
    - It is also is highlighted in **'JACS Select Online Issue 31, December 2014: 'Protein Dynamics in Simulation and Experiment'.**
12. Hema Chandra Kotamarthi, Riddhi Sharma, and Sri Rama Koti Ainavarapu*, Single-molecule studies on polySUMOs proteins reveal their mechanical flexibility, ***Biophysical Journal***, Vol. 104 (2013) p2273-2281.

This publication is one of the "TOP 20 Most Accessed Articles" in May-June 2013 from the *Biophysical Journal* website.

13. Venkatraman Ramanujam, K.V.R. Chary, and Sri Rama Koti Ainavarapu*, Iterative cloning, overexpression, purification and isotopic labeling of an engineered dimer of a Ca^{2+}-binding protein of the βγ-crystallin superfamily from *Methanosarcina acetivorans*, ***Protein Expression Purif.***, Vol. 84 (2012) p116-122.

    This publication is in the "TOP 20 Hottest Articles in Biochemistry, Genetics and Molecular Biology of Protein Expression and Purification", April-June 2012.

14. Vasudha Aggarwal, S.R. Kulothungan, M.M. Balamurali, S.R. Saranya, Raghavan Varadarajan, and Sri Rama Koti Ainavarapu*, Ligand modulated parallel mechanical unfolding pathways of Maltose Binding Proteins (MBPs). ***J. Biol. Chem.,*** Vol. 286 (2011) p28056-28065.
15. Lorna Dougan, Sri Rama Koti Ainavarapu, Georgi Genchev, Hui Lu, and Julio M. Fernandez, A Single-Molecule Perspective on the Role of Solvent Hydrogen Bonds in Protein Folding and Chemical Reactions, ***ChemPhysChem.,*** Vol. 9 (2008), p2836-2847.
16. Sri Rama Koti Ainavarapu*, Arun P. Wiita, Lorna Dougan, Einar Uggerud and J.M. Fernandez*, Single-molecule force spectroscopy measurements of bond elongation during a bimolecular reaction, ***J. Am. Chem. Soc.***, Vol. 130 (2008), p6479-6487.

    This publication has been highlighted in Research Highlights of **Nature (2008)**, Vol. 453, p261, with the title **"Disulphide dichotomies"**.

17. Sri Rama Koti Ainavarapu*, Arun P. Wiita, Hector H. Huang, and J.M. Fernandez, A Single-Molecule Assay to Directly Identify Solvent Accessible Disulfide Bonds and Probe Their Effect on Protein Folding, ***J. Am. Chem. Soc.***, Vol. 130 (2008), p436-437.
18. Robert Szoszkiewicz, Sri Rama Koti Ainavarapu**,** Arun P. Wiita, Raul Perez-Jimenez, Jose M. Sanchez-Ruiz, and J. M. Fernandez, Dwell Time Analysis of a Single-Molecule Mechanochemical Reaction, ***Langmuir***, Vol. 24 (2008), p1356-1364.
19. Sri Rama Koti Ainavarapu, Jasna Brujic, Hector H. Huang, Arun P. Wiita, Lewyn Li, Hui Lu, Kirstin Walther, Mariano Carrion-Vazquez, Hongbin Li, and J.M. Fernandez, Contour length and refolding rate of a small protein controlled by engineered disulfide bonds, ***Biophysical Journal***, Vol. 92 (2007), p225-233.
20. Raul Perez-Jimenez, Sergi Garcia-Manyes, Sri Rama Koti Ainavarapu, and J.M. Fernandez Mechanical Unfolding Pathways of the Enhanced yellow Fluorescent Protein Revealed by Single-Molecule Force Spectroscopy, ***J. Biol. Chem.,*** Vol. 281 (2006), p40010-40014.
21. Arun P. Wiita, Sri Rama Koti Ainavarapu**,** Hector H. Huang, and J.M. Fernandez, Force-dependent chemical kinetics of disulfide bond reduction observed with single-molecule techniques, ***Proc. Natl. Acad. Sci. USA***, Vol. 103 (2006), p7222-7227.

    Commentary on this publication is reported in PNAS (2006), *103*, p7533: "Covalent chemistry on distended proteins."

22. Sri Rama Koti Ainavarapu, Lewyn Li and J.M. Fernandez, Fingerprinting DHFR in single-molecule AFM studies, ***Biophysical Journal,*** Vol. 91 (2006), p2009-2010.
23. Sri Rama Koti Ainavarapu, Lewyn Li, Carmen L. Badilla and J.M. Fernandez, Ligand binding modulates the mechanical stability of dihydrofolate reductase (DHFR), ***Biophysical Journal***, Vol. 89 (2005), p3337-3344.
24. M.K. Singh, H. Pal, Sri Rama Koti Ainavarapu and A.V. Sapre, Photophysical Properties and Rotational Relaxation Dynamics of Neutral Red Bound to *β*-cyclodextrin, ***J. Phys. Chem. A***, Vol. 108 (2004), p1465-1474.
25. C. Tiseanu, M.U. Kumke, Sri Rama Koti Ainavarapu, and V.I.Parvulescu. Lanthanides distribution in ZSM-5/MCM-41 hybrid materials, ***J. Photochem. Photobiol. A: Chemistry,*** Vol. 187 (2007), p299-304.

26. Sri Rama Koti Ainavarapu, Jharna Taneja and N. Periasamy, Control of Coherence length and Aggregation size in the J-aggregate of Porphyrin, ***Chem. Phys. Lett.,*** Vol. 375 (2003), p171-176.
27. N. Periasamy and Sri Rama Koti Ainavarapu, Time Resolved Fluorescence Spectroscopy: TRES and TRANES, ***PINSA,*** Vol. 69 (2003) p41-48.
28. Sri Rama Koti Ainavarapu and N. Periasamy, Self-Assembly of Template-Directed J-aggregates of Porphyrin, ***Chemistry of Materials,*** Vol. 15 (2003), p369-371.
29. Ira, Sri Rama Koti Ainavarapu, G. Krishnamoorthy and N. Periasamy, TRANES Spectra of Fluorescence Probes in Lipid Bilayer Membranes: An Assessment of Population Heterogeneity and Dynamics, ***Journal of Fluorescence,*** Vol. 13 (2003), p95-103.
30. Sri Rama Koti Ainavarapu and N. Periasamy, Time Resolved Area Normalized Emission Spectroscopy (TRANES) of DMABN Confirms Emission from Two States, ***Res. Chem. Inter.***, Vol. 28 (2002), p831-836.
31. Sri Rama Koti Ainavarapu and N. Periasamy, Cyanine induced Aggregation in *meso*-tetrakis (4-sulphonatophenyl) Porphyrin Anions, ***J. Mat. Chem.,*** Vol. 12 (2002), p2312-2317.
32. Sri Rama Koti Ainavarapu and N. Periasamy, Application of Time Resolved Area Normalized Emission Spectroscopy (TRANES) to multi-component systems, ***J. Chem. Phys.,*** Vol. 115 (2001), p7094-7099.

    Research work of this publication has been referred in **Principles of Fluorescence Spectroscopy, 3rd edition, by J.R. Lakowicz**, chapter 7, p237-276.
33. Sri Rama Koti Ainavarapu and N. Periasamy, TRANES Analysis of the Fluorescence of Nile Red in Organized Molecular Assemblies Confirms Emission from Two Species, ***Proc. Indian Acad. Sci. (Chem. Sci.),*** Vol. 113 (2001), p157-163.
34. Sri Rama Koti Ainavarapu, M.M.G. Krishna and N. Periasamy, Time-Resolved Area-Normalized Emission Spectroscopy (TRANES): A Novel Method for Confirming Emission from Two Excited States, ***J. Phys. Chem. A,*** Vol. 105 (2001), p1767-1771.
35. Sri Rama Koti Ainavarapu, B. Bhattacharjee, N.S. Haram, Ranjan Das, N. Periasamy, N.D. Sonawane, D.W. Rangnekar, Photophysics of some styryl thiazolo quinoxaline dyes in organic media, ***J. Photochem. Photobiol. A: Chemistry,*** Vol. 137 (2000), p115-123.
36. Sri Rama Koti Ainavarapu and N. Periasamy, Solvent Exchange in Excited-State Relaxation in Mixed Solvents, ***Journal of Fluorescence***, Vol. 10 (2000), p177-184.
37. Prasanta K. Patel, Sri Rama Koti Ainavarapu and R.V. Hosur, NMR studies on truncated sequences of human telomeric DNA: observation of a novel A-tetrad, ***Nucl. Acids Res.***, Vol. 27 (1999), p3836-3843.

Conference Proceedings Published in Journals:

1. Mona Gupta, Ravindra Venkatramani, Sri Rama Koti Ainavarapu*, Moving Beyond the Mechanical Clamp: An Exploration into Differential Mechanical Stability of Ubiquitin Family Proteins, 62nd Annual Biophysical Society Meeting ***Biophysical Journal,*** Vol. 114 (2018), p386a.
2. Anirban Das, Anju Yadav, Barun Kumar Maity, A. Korn, J. Adler, Sri Rama Koti Ainavarapu, Daniel Huster, Sudipta Maiti*, Designing Ligands for Structure-Less Proteins, 62nd Annual Biophysical Society Meeting ***Biophysical Journal,*** Vol. 114 (2018), p589a.
3. S. Bhattacharyya and Sri Rama Koti Ainavarapu*, Temperature-Dependent Protein Malleability Probed by Single-Molecule Force Spectroscopy and Fluorescence Spectroscopy, 61st Annual Biophysical Society Meeting ***Biophysical Journal,*** Vol. 112 (2017), p300a.
4. Anju Yadav, Sanjoy Paul, Ravindra Venkatramani, Sri Rama Koti Ainavarapu*, Structural and Mechanistic Insights into the Copper-Modulated Unfolding Pathways of Azurin, 61st Annual Biophysical Society Meeting ***Biophysical Journal,*** Vol. 112 (2017), p456a.

5. Anju Yadav, Sanjoy Paul, Ravindra Venkatramani, Sri Rama Koti Ainavarapu*, Examining the Mechanical Properties of Copper Binding Azurin using Single Molecule Force Spectroscopy and Steered Molecular Dynamics, 60th Annual Biophysical Society Meeting ***Biophysical Journal,*** Vol. 110 (2016), p496a.
6. Sri Rama Koti Ainavarapu*, Quantification of Protein Dynamics in terms of Flexibility/Rigidity by Single-Molecule Force Spectroscopy Experiments. National Symposium on Biophysics & Golden Jubilee Meeting of Indian Biophysical Society (2015), ***Journal of Proteins and Proteomics,*** Vol. *6* (2015), JPP11-12.
7. Ranja Sarkar, Hema Chandra Kotamarthi, Sri Rama Koti Ainavarapu, Ravindra Venkatramani*, Relative Mechanical Flexibility of Ubiquitin Family Proteins: A Study using Elastic Network Model. 59th Annual Biophysical Society Meeting, ***Biophysical Journal,*** Vol. 108 (2015), p60a.
8. Hema Chandra Kotamarthi, Satya Narayan, and Sri Rama Koti Ainavarapu*, Forced Unfolding of Periplasmic Binding Proteins (PBPS) Follows Kinetic Partitioning. 58th Annual Biophysical Society Meeting, ***Biophysical Journal,*** Vol. 106 (2014), p670a.
9. Hema Chandra Kotamarthi, Ravindra Venkatramani, and Sri Rama Koti Ainavarapu*, Experimental and Simulation Studies on the Mechanical Properties of SUMO proteins. 58th Annual Biophysical Society Meeting, ***Biophysical Journal,*** Vol. 106 (2014), p390-391a.
10. Ravindra Venkatramani*, Ranja Sarkar, Hema Chandra Kotamarthi, and Sri Rama Koti Ainavarapu, Assessing Limitations of Elastic Network Models in Describing Equilibrium Protein Flexibility and Extensions to Predict Non-Equilibrium Unfolding Dynamics of Proteins. 58th Annual Biophysical Society Meeting, ***Biophysical Journal,*** Vol. 106 (2014), p412a.
11. Hema Chandra Kotamarthi, R. Sharma, and Sri Rama Koti Ainavarapu*, Single-Molecule Force Spectroscopy Studies on Sumo Polyproteins Reveal their Mechanical Flexibility. 57 th Annual Biophysical Society Meeting, ***Biophysical Journal,*** Vol. 104 (2013), p167a.
12. Sri Rama Koti Ainavarapu*, Parallel unfolding pathways of large two-domain proteins probed by single-molecule force spectroscopy. International Interdisciplinary Science Conference on Protein Folding and Diseases (2012), ***Journal of Proteins and Proteomics,*** Vol. 3 (2012), JPP4.
13. Vasudha Aggarwal, S R. Kulothungan, Saranya Rajaram, MM Balamurali, Raghavan Varadarajan, and Sri Rama Koti Ainavarapu*, Single-molecule studies of the parallel unfolding pathways of Maltose Binding Protein (MBP), 55th Annual Biophysical Society Meeting, ***Biophysical Journal,*** Vol. 100 (2011), p481a.
14. Raul Perez-Jimenez, S.G. Manyes, Sri rama Koti Ainavarapu, and J.M. Fernandez Mechanical unfolding pathways of EYFP revealed by single-molecule force spectroscopy, 51st Annual Biophysical Society Meeting, ***Biophysical Journal***, Supplement (2007), p371A.
15. Sri rama Koti Ainavarapu, J. Bruijic, and J.M. Fernandez, Contour length and refolding rate of a small protein controlled by engineered disulfide bonds, 51st Annual Biophysical Society Meeting, ***Biophysical Journal***, Supplement (2007), p553A.
16. Sri Rama Koti Ainavarapu**,** H.H. Huang, A.P. Wiita, M. Carrion-Vazquez, and J.M. Fernandez, Liberation of sequestered residues by forced rupture of single disulfide bridges, 49th Annual Biophysical Society Meeting, ***Biophysical Journal***, Vol. 88 (2005), p168A.
17. Sri rama Koti Ainavarapu, L. Li, C. L. Badilla, and J.M. Fernandez, Ligand binding modulates the mechanical stability of dihydrofolate reductase (DHFR), 49th Annual Biophysical Society Meeting, ***Biophysical Journal***, Vol. 88 (2005), p168A.
18. Sri Rama Koti Ainavarapu, A. Sarkar, R.B. Robertson, C. L. Badilla, and J.M. Fernandez, Single molecule force and fluorescence studies of the Enhanced Green Fluorescent Protein (EGFP), 48th Annual Biophysical Society Meeting, ***Biophysical Journal***, Vol. 86 (2004), p529A.

In science magazine/bulletin:

19. Sri Rama Koti Ainavarapu*, Single-molecule force-clamp spectroscopy: Probing transition states of mechanically activated chemical reactions, ***ISRAPS Bulletin***, Vol. 21 (2009), p32-39.
20. N. Periasamy and Sri Rama Koti Ainavarapu, Time Resolved Fluorescence Spectroscopy: TRES vs TRANES, ***ISRAPS Bulletin***, Vol. 12 (2001), p26-29.