

CURRICULUM VITAE OF PROF. SHRIPAD P. MAHULIKAR

1. Personal Details:

- (a) Name & Designation: Dr. Shripad P. Mahulikar, Professor (Full)
 (b) Affiliation: Dept. of Aerospace Engg. Indian Institute of Technology Bombay
 (c) Date of Birth: 3rd September 1968, (d) Citizenship: Indian
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2. Educational & Professional Qualifications (reverse chronological order):

No.	Deg. / Title	Institution	Year	Discipline	Class
i.	A. von Humboldt Fellow	Alexander von Humboldt Foundation, Germany	Jul'2003	Thermo-fluids	
ii.	Chartered Engineer	Engineering Council London, U.K.	Oct'2001	reg. no. 470997 (with Membership of: <i>Royal Aero. Society, London</i>)	
iii.	Doctor of Philosophy (PhD)	Nanyang Technological University, Singapore	May'1999	Microscale Thermal & Fluids Science	Thesis adjudged Excellent
iv.	Competent Toastmaster	Toastmasters' International Inc. USA	Feb'1999	Communication & Leadership	
v.	Master of Technology <i>by Research</i>	Indian Institute of Technology Bombay	May'1992	Aerospace Engineering	I
vi.	Bachelor of Technology	Indian Institute of Technology Bombay	Jul'1990	Aeronautical Engineering	I

3. Work Experience & Research Collaborations (reverse chronological order):

No.	Organisation	Position	Period	Duties
(1)	<i>Hamburg University of Technology, GERMANY</i>	<i>DFG-Mercator Full Prof. (Vstg.)</i>	<i>Dec'2011 – Dec'2012</i>	<i>Academic Research & Higher Educat.</i>
(2)	<i>Gyeongsang National University, S. KOREA</i>	<i>On Special Invitation</i>	<i>Dec'2010 & May-Jun'2010</i>	<i>Academic Research & Special Lectures</i>
(3)	<i>Hamburg University of Technology, GERMANY</i>	<i>A. von Humboldt Fellow (3rd Term)</i>	<i>Apr'2009 - Jul'2009</i>	<i>Academic Research & Special Lectures</i>
(4)	Indian Institute of Technology (IIT) Bombay, INDIA	Full Professor: Aerospace Dept.	Mar'2009 onwards	Academic Research & Higher Educat.
(5)	<i>China Jiliang University, P.R. CHINA</i>	<i>On Special Invitation</i>	<i>Dec'2008 & Jun'2005</i>	<i>Academic Research & Special Lectures</i>
(6)	IIT Bombay, INDIA (Dept. of Aerospace Engg.)	Associate Professor	Mar'2005 - Feb'2009	Academic Research & Training
(7)	<i>Hamburg University of Technology, GERMANY</i>	<i>A. von Humboldt Fellow (2nd Term)</i>	<i>Apr'2007 - Jul'2007</i>	<i>Academic Research</i>
(8)	<i>Helsinki University of Technology, FINLAND</i>	<i>Visiting Professor</i>	<i>May'2006 - Jun'2006</i>	<i>Academic Research & Training</i>
(9)	<i>Hamburg University of Technology, GERMANY</i>	<i>A. von Humboldt Fellow (1st Term)</i>	<i>Jul'2003 - Aug'2004</i>	<i>Academic Research & Special Lectures</i>
(10)	IIT Bombay, INDIA (Dept. of Aerospace Engg.)	Assistant Professor	Jan'2000 - Feb'2005	Academic Research & Training

<u>No.</u>	<u>Organisation</u>	<u>Position</u>	<u>Period</u>	<u>Duties</u>
(11)	Nanyang Technological University (N.T.U.) SINGAPORE	Post-Doctoral Research Fellow	Dec'1999 - Jan'2000	Academic Research
(12)	N.T.U. SINGAPORE (School of Mech. & Aero. Engg.)	Research Engineer	Oct'1998 - Nov'1999	Academic Research
(13)	Naval College of Engineering, INS Shivaji, Lonavla, INDIA	Scientist 'C'	Jul'1995 - Nov'1995	Training & R&D
(14)	Naval College of Engineering, INS Shivaji, Lonavla, INDIA	Scientist 'B'	Dec'1993 - Jun'1995	Training & R&D
(15)	Defence Research & Development Laboratory, Hyderabad, INDIA	Scientist 'B'	Feb'1992 - Dec'1993	R&D
(16)	IIT Bombay, INDIA (Dept. of Aeronautical Engg.)	Senior Research Scientist	May'1990 - Jul'1990	R&D

Kindly Note –

- Change of work place, Sr. no. (15) → (14), is an inter-departmental transfer; & change of positions, Sr. nos. (14) → (13), (10) → (6), and (6) → (4), are promotions within the organisation.
- Work experience from Sr. nos. (15) - (13), included the successful completion of Govt. of India's scholarship bond period of 3-years.
- Awarded performance bonus for service at NTU – Singapore [Sr. nos. (12) & (11)].

Following appointments outside IIT Bombay after Jan'2000 (italicised in above table) are collaborations -

- A. von Humboldt Fellowship's (grant no. 1104249/INI) 1st, 2nd, and 3rd terms, Sr. nos. (9), (7), & (3), respectively, were on deputation from IIT Bombay, Sr. nos. (10), (6), & (4), respectively.*
- Appointment in Helsinki Univ. Tech. (HUT, now renamed as, Aalto Univ.) Sr. no. (8), funded by HUT's Visiting Professorship programme, was during vacation from Sr. no. (6).*
- Invitation in China Jiliang Univ. Sr. no. (5), funded by Foreign Experts' Program for Scientific Research, Zhejiang Province, P.R. China, grant no. 2008-607, was during vacation from Sr. no. (6).*
- Invitation in Gyeongsang Nat. Univ. Sr. no. (2), funded by Priority Research Centers Program, National Research Foundation of Korea, grant no. 2009-0094016, was during vacation from Sr. no. (4).*
- Appointment in Hamburg Univ. Tech. Sr. no. (1), funded by DFG's Mercator Professorship programme, grant no. T-ZW-M21-DFG-1131, is during Sabbatical Leave from Sr. no. (4).*

4. List of Research Publications (reverse chronological order):

a. Journal Publications:

- Sonawane, H.R., & **Mahulikar, S.P.**, 2013, Effect of missile turn rate on aircraft susceptibility to IR guided missile, *AIAA Journal of Aircraft*, doi: 10.2514/1.C031902, in press (with PhD student).
- Mahulikar, S.P.**, & Herwig, H., 2013 (Jan), Thermodynamic analysis of a Schwarzschild black-hole fed by cosmic microwave background radiation, *European Physical Journal C: Particles & Fields*, Vol. 73, No. 1, art. no. 2292 (8 pp).
- Mahulikar, S.P.**, & Herwig, H., 2012 (Oct), Exact solution for energy analysis of Schwarzschild black-hole fed by CMBR, *Astrophysics & Space Science*, Vol. 341, No. 2, pp. 417-420.
- Mahulikar, S.P.**, Gulhane, N.P., Pradhan, S.D., Hrisheekesh, K., & Prabhu, S.V., 2012 (Jul-Sep), Pressure drop characteristics in continuum-based laminar compressible micro-convective flow, *Nanoscale & Microscale Thermophysical Engineering*, Vol. 16, No. 3, pp. 181-197.
- Mahulikar, S.P.**, Vijay, S., Potnuru, S.K., & Reddam, D.N.S., 2012 (Jul), Aircraft engine's lock-on envelope due to internal and external sources of infrared signature, *IEEE Transactions on Aerospace & Electronic Systems*, Vol. 48, No. 3, pp. 1914-1923.
- Gulhane, N.P., & **Mahulikar, S.P.**, 2012 (Jun), Numerical investigation on laminar micro-convective liquid flow with entrance effect and Graetz problem due to variation in thermal properties, *Heat Transfer Engineering*, Vol. 33, No. 8, pp. 748-761 (with PhD student).

- (7) Sonawane, H.R., & **Mahulikar, S.P.**, 2011 (Jun), Tactical air warfare: Generic model for aircraft susceptibility to infrared guided missiles, *Aerospace Science & Technology*, Vol. 15, No. 4, pp. 249-260 (with PhD student).
- (8) Gulhane, N.P., & **Mahulikar, S.P.**, 2011 (Jan-Mar), Numerical study of microconvective water-flow characteristics with variations in properties, *Nanoscale & Microscale Thermophysical Engineering*, Vol. 15, No. 1, pp. 28-47 (with PhD student).
- (9) **Mahulikar, S.P.**, Herwig, H., Zhou, J.W., & Sodhani, Y.M., 2011 (Jan), Surface radiative transfer in gas-to-gas cocurrent micro heat exchanger, *AIChE Journal*, Vol. 57, No. 1, pp. 40-50 (reported in scientific press release = <http://www.verticalnews.com/premium_newsletters/Chemicals-and-Chemistry/2011-02-18/67041CH.html>).
- (10) **Mahulikar, S.P.**, Kumar. R., Tripathi, M.S., & Pasari, L.K., 2010 (Dec), A modified dimensionless number and geometric symmetry in annulus convection with viscous dissipation, *International Journal of Heat & Mass Transfer*, Vol. 53, Nos. 25-26, pp. 5976–5983 [reported in scientific press release = (i) Vertical-News: ‘Physics’- <<http://physics.verticalnews.com/articles/4692363.html>>, (ii) High-Beam Research- <<http://www.highbeam.com/doc/1G1-244794262.html>>].
- (11) Gulhane, N.P., & **Mahulikar, S.P.**, 2010 (May), Numerical study of compressible convective heat transfer with variations in all fluid properties, *International Journal of Thermal Sciences*, Vol. 49, No. 5, pp. 786-796 (with PhD student).
- (12) **Mahulikar, S.P.**, & Herwig, H., 2009 (Aug), Exact thermodynamic principles for dynamic order existence and evolution in chaos, *Chaos, Solitons & Fractals*, Vol. 41, No. 4, pp. 1939-1948 [cited in Wikipedias: (i) ‘Negentropy’- <<http://en.wikipedia.org/wiki/Negentropy>>, (ii) ‘Entropy in thermodynamics and information theory’- <http://en.wikipedia.org/wiki/Entropy_in_thermodynamics_and_information_theory>].
- (13) **Mahulikar, S.P.**, Potnuru, S.K., & Rao, G.A., 2009 (Apr), Study of sunshine, skyshine, and earthshine for aircraft infrared detection, *Journal of Optics A: Pure & Applied Optics*, Vol. 11, No. 4, art. no. 045703 (10 pp.) [cited in Wikipedia: ‘Infrared signature’- <http://en.wikipedia.org/wiki/Infrared_signature>].
- (14) Gulhane, N.P., & **Mahulikar, S.P.**, 2009 (Mar), Variations in gas properties in laminar micro-convection with entrance effect, *International Journal of Heat & Mass Transfer*, Vol. 52, Nos. 7-8, pp. 1980-1990 (with PhD student).
- (15) **Mahulikar, S.P.**, Khurana, S., Dungarwal, R., Shevakari, S.G., Subramanian, J., & Gujarathi, A.V., 2008 (Oct-Dec), Transient aero-thermal mapping of passive thermal protection system for nose-cap of reusable hypersonic vehicle, *Journal of the Astronautical Sciences*, Vol. 56, No. 4, pp. 593-619.
- (16) **Mahulikar, S.P.**, Prasad, H.S.S., & Potnuru, S.K., 2008 (May-Jun), Infrared signature suppression of helicopter engine duct based on ‘conceal and camouflage’, *AIAA Journal of Propulsion & Power*, Vol. 24, No. 3, pp. 613-618 (cited in Wikipedia: ‘Infrared signature’- <http://en.wikipedia.org/wiki/Infrared_signature>).
- (17) **Mahulikar, S.P.**, & Herwig, H., 2008 (Mar), Fluid friction in incompressible laminar convection: Reynolds’ analogy revisited for variable fluid properties, *European Physical Journal B: Condensed Matter & Complex Systems*, Vol. 62, No. 1, pp. 77-86 (cited in Wikipedia: ‘Reynolds analogy’- <http://en.wikipedia.org/wiki/Reynolds_analogy>).
- (18) **Mahulikar, S.P.**, Herwig, H., & Hausner, O., 2007 (Dec), Study of gas microconvection for synthesis of rarefaction and nonrarefaction effects, *IEEE/ASME Journal of Microelectromechanical Systems*, Vol. 16, No. 6, pp. 1543-1556 (reported in scientific press release = Vertical-News: ‘Electronics News-Weekly’- <http://www.verticalnews.com/premium_newsletters/Electronics-Newsweekly/2008-03-03/62447ELE.html>).
- (19) **Mahulikar, S.P.**, Sonawane, H.R., & Rao, G.A., 2007 (Oct-Nov), Infrared signature studies of aerospace vehicles, *Progress in Aerospace Sciences*, Vol. 43, Nos. 7-8, pp. 218-245 [cited in Wikipedias: (i) ‘Stealth technology’- <http://en.wikipedia.org/wiki/Stealth_technology>, (ii) ‘Stealth aircraft’- <http://en.wikipedia.org/wiki/Stealth_aircraft>, (iii) ‘Infrared’- <<http://en.wikipedia.org/wiki/Infrared>>, (iv) ‘Infra-red search and track’- <http://en.wikipedia.org/wiki/Infra-red_search_and_track>, (v) ‘Infrared signature’- <http://en.wikipedia.org/wiki/Infrared_signature>].
- (20) **Mahulikar, S.P.**, Potnuru, S.K., & Kolhe, P.S., 2007 (Aug), Analytical estimation of solid angle subtended by complex well-resolved surfaces for infrared detection studies, *Applied Optics*, Vol. 46, No.

- 22, pp. 4991-4998 (cited in Wikipedia: 'Infrared signature'-
<http://en.wikipedia.org/wiki/Infrared_signature>).
- (21) Zhou, J.-W., & **Mahulikar, S.P.**, 2006 (Oct-Dec), Cooling characteristics during bath quenching of test probe using inverse heat transfer, *Experimental Heat Transfer*, Vol. 19, No. 4, pp. 297-308 (from: collaboration with China Jiliang Univ.).
 - (22) Herwig, H., & **Mahulikar, S.P.**, 2006 (Oct), Variable property effects in single-phase incompressible flows through microchannels, *International Journal of Thermal Sciences*, Vol. 45, No. 10, pp. 977-981 (from: A. von Humboldt Fellowship).
 - (23) **Mahulikar, S.P.**, & Herwig, H., 2006 (Sep), Physical effects in pure continuum-based laminar micro-convection due to variation of gas properties, *Journal of Physics D: Applied Physics*, Vol. 39, No. 18, pp. 4116-4123.
 - (24) **Mahulikar, S.P.**, & Herwig, H., 2006 (Jul), Physical effects in laminar microconvection due to variations in incompressible fluid properties, *Physics of Fluids*, Vol. 18, No. 7, art. no. 073601 (12 pp).
 - (25) **Mahulikar, S.P.**, Rao, G.A., & Kolhe, P.S., 2006 (Jan-Feb), Infrared signatures of low flying aircraft and their rear fuselage skin's emissivity optimization, *AIAA Journal of Aircraft*, Vol. 43, No. 1, pp. 226-232 (cited in Wikipedia: 'Infrared signature'- <http://en.wikipedia.org/wiki/Infrared_signature>).
 - (26) Rao, G.A., & **Mahulikar, S.P.**, 2005 (Nov), New criterion for aircraft susceptibility to infrared homing missiles, *Aerospace Science & Technology*, Vol. 9, No. 8, pp. 701-712 (with PhD student) (cited in Wikipedia: 'Infrared signature'- <http://en.wikipedia.org/wiki/Infrared_signature>).
 - (27) **Mahulikar, S.P.**, 2005 (Nov), Theoretical aerothermal concepts for configuration design of hypersonic vehicles, *Aerospace Science & Technology*, Vol. 9, No. 8, pp. 681-685.
 - (28) **Mahulikar, S.P.**, & Sane, S.K., 2005 (Sep), Theoretical analysis of experimentally observed perplexing calibration characteristics of ball-in-vortex flow-meter, *ASME Journal of Fluids Engineering*, Vol. 127, No. 5, pp. 1021-1028.
 - (29) **Mahulikar, S.P.**, Rao, G.A., Sane, S.K., & Marathe, A.G., 2005 (Jul-Sep), Aircraft plume infrared signature in non-afterburning mode, *AIAA Journal of Thermophysics & Heat Transfer*, Vol. 19, No. 3, pp. 413-415 (cited in Wikipedia: 'Infrared signature'- <http://en.wikipedia.org/wiki/Infrared_signature>).
 - (30) Rao, G.A., & **Mahulikar, S.P.**, 2005 (Jul-Aug), Effect of atmospheric transmission and radiance on aircraft infrared signatures, *AIAA Journal of Aircraft*, Vol. 42, No. 4, pp. 1046-1054 (with PhD student) (cited in Wikipedia: 'Infrared signature'- <http://en.wikipedia.org/wiki/Infrared_signature>).
 - (31) **Mahulikar, S.P.**, Kolhe, P.S., & Rao, G.A., 2005 (Jan-Mar), Skin temperature prediction of aircraft rear fuselage with multi-mode thermal model, *AIAA Journal of Thermophysics & Heat Transfer*, Vol. 19, No. 1, pp. 114-124 (cited in Wikipedia: 'Infrared signature'- <http://en.wikipedia.org/wiki/Infrared_signature>).
 - (32) **Mahulikar, S.P.**, & Herwig, H., 2005 (Jan), Theoretical investigation of scaling effects from macro-to-microscale convection due to variations in incompressible fluid properties, *Applied Physics Letters*, Vol. 86, No. 1, art. no. 014105 (3 pp).
 - (33) **Mahulikar, S.P.**, Herwig, H., Hausner, O., & Kock, F., 2004 (Dec), Laminar gas micro-flow convection characteristics due to steep density gradients, *Europhysics Letters*, Vol. 68, No. 6, pp. 811-817.
 - (34) **Mahulikar, S.P.**, & Herwig, H., 2004 (Oct), Conceptual investigation of the entropy principle for identification of directives for creation, existence and total destruction of order, *Physica Scripta*, Vol. 70, No. 4, pp. 212-221.
 - (35) Rao, G.A., & **Mahulikar, S.P.**, 2002 (Dec), Integrated review of stealth technology and its role in airpower, *Aeronautical Journal*, Vol. 106, No. 1066, pp. 629-641 (with PhD student) [cited in Wikipedias: (i) 'Stealth technology'- <http://en.wikipedia.org/wiki/Stealth_technology>, (ii) 'Stealth aircraft'- <http://en.wikipedia.org/wiki/Stealth_aircraft>, (iii) 'Infrared signature'- <http://en.wikipedia.org/wiki/Infrared_signature>].
 - (36) **Mahulikar, S.P.**, & Tso, C.P., 2002 (Mar), A new classification for thermal-development of fluid flow in a circular tube under laminar forced convection, *Proceedings of the Royal Society (London) Series A: Mathematical, Physical & Engineering Sciences*, Vol. 458, No. 2019, pp. 669-682.
 - (37) **Mahulikar, S.P.**, Sane, S.K., Gaitonde, U.N., & Marathe A.G., 2001 (Apr), Numerical studies of infrared signature levels of complete aircraft, *Aeronautical Journal*, Vol. 105, No. 1046, pp. 185-192 (cited in Wikipedia: 'Infrared signature'- <http://en.wikipedia.org/wiki/Infrared_signature>).

- (38) Tso, C.P., & **Mahulikar, S.P.**, 2000 (May), Experimental verification of the role of Brinkman number in microchannels using local parameters, *International Journal of Heat & Mass Transfer*, Vol. 43, No. 10, pp. 1837-1849 (from PhD Thesis).
- (39) Tso, C.P., & **Mahulikar, S.P.**, 2000 (Mar), Combined evaporating meniscus-driven convection & radiation in annular microchannels for electronics cooling application, *International Journal of Heat & Mass Transfer*, Vol. 43, No. 6, pp. 1007-1023 (from PhD Thesis).
- (40) Tso, C.P., & **Mahulikar, S.P.**, 1999 (Jul-Sep), View factors between finite length rings on an interior cylindrical shell, *AIAA Journal of Thermophysics & Heat Transfer*, Vol. 13, No. 3, pp. 375-379 (from PhD Thesis).
- (41) Tso, C.P., & **Mahulikar, S.P.**, 1999 (May), The role of the Brinkman number in analysing flow transitions in microchannels, *International Journal of Heat & Mass Transfer*, Vol. 42, No. 10, pp. 1813-1833 (from PhD Thesis).
- (42) Tso, C.P., & **Mahulikar, S.P.**, 1999 (Jan-Mar), View factor for ring elements on coaxial cylinders, *AIAA Journal of Thermophysics & Heat Transfer*, Vol. 13, No. 1, pp. 155-158 (from PhD Thesis).
- (43) Tso, C.P., & **Mahulikar, S.P.**, 1998 (Jun), The use of the Brinkman number for single phase forced convective heat transfer in microchannels, *International Journal of Heat & Mass Transfer*, Vol. 41, No. 12, pp. 1759-1769 (from PhD Thesis).
- (44) Tso, C.P., & **Mahulikar, S.P.**, 1996 (Dec), Simulation of evaporating meniscus-driven flow for application to electronics cooling design, *Journal of Electronics Manufacturing*, Vol. 6, No. 4, pp. 231-241 (from PhD Thesis).
- (45) Singh, V.P., **Mahulikar, S.P.**, & Raja, A.T., 1995 (Dec), Infrared signature suppression system for marine gas turbine exhaust, *Journal of Marine Engineering*, Vol. 33, pp. 42-47 (from INS-Shivaji's internal project).

Book:

Gulhane, N.P., & **Mahulikar, S.P.**, 2011, *Laminar Micro-Convection of Gas and Liquid*, ISBN 978-3-8433-9189-4, LAP Lambert Academic Publishing GmbH & Co. KG, Saarbrücken, F.R. Germany, 144 pgs. (with PhD student).

b. Reviewer for Scientific Journals:

- *ASME Journal of Heat Transfer* (received *Outstanding Reviewer Award* in 2007)
- *Proceedings of the Royal Society (London) Series A: Mathematical, Physical & Engineering Sciences*
- *Microfluidics & Nanofluidics*
- *International Journal of Heat & Mass Transfer*
- *International Journal of Thermal Sciences*
- *Infrared Physics & Technology*
- *AIAA Journal of Propulsion & Power*
- *AIAA Journal of Thermophysics & Heat Transfer*
- *Measurement*
- *Heat and Mass Transfer (Wärme- und Stoffübertragung)*
- *Heat Transfer Engineering*
- *Computer Modeling in Engineering & Sciences*
- *Aerospace Science & Technology*
- *Microelectronics Journal*
- *Journal of Process Mechanical Engg. (Proc. I. Mech. E. Part E)*
- *Chemical & Biochemical Engineering Quarterly*
- *Defence Science Journal*

c. Significant Contributions to International Conferences:

- i. **Mahulikar, S.P.**, Gulhane, N.P., Pradhan, S.D., & Prabhu, S.V., 2011 (Jul), Keynote Lect. 'Pressure drop in laminar micro-convective flow due to variable properties of compressible fluid', 7th *International Conference on Computational Heat and Mass Transfer*, Istanbul, Turkey.
- ii. **Mahulikar, S.P.**, 2011 (Jul), Chairman for Session B6: "Micro & Nano Flows", 7th *International Conference on Computational Heat and Mass Transfer*, Istanbul, Turkey.

- iii. **Mahulikar, S.P.**, 2009 (Aug), Chairman for Session 2P1 - Remote Sensing, Imaging & Detection, *Progress in Electromagnetics Research Symposium (PIERS-2009)*, Moscow, Russia.
- iv. **Mahulikar, S.P.**, 2005 (May), Chairman for keynote lect. entitled ‘Ab initio molecular dynamics approach to hydrodynamic flow,’ delivered by: Prof. D.C. Rapaport, Head - Physics Dept., Bar-Ilan University, Israel, 4th *International Conference on Computational Heat and Mass Transfer*, Paris-Cachan, France.
- v. **Mahulikar, S.P.**, 2005, Member of Selection Committee (representing India) for selection of manuscripts for scientific journals from: *Proceedings of 4th International Conference on Computational Heat and Mass Transfer*, Paris-Cachan, France.

d. *Conference Publications*: Ref. Annexure to C.V. (1)

5. *Claims of Seminal Contributions in Research (in reverse chronological order)*:

- a) Analytically obtained the rate of energy and entropy variation of a Schwarzschild black-hole fed by CMBR [ref. 4.a.(2)]: The entropy analysis revealed that there is a higher value of black-hole’s critical mass than that obtained from an energy analysis, which is needed for its existence with high probability.
- b) Obtained for exact analytical solution for energy analysis of Schwarzschild black-hole fed by Cosmic Micro-wave Background Radiance (CMBR) [ref. 4.a.(3)]: This unique solution holds for both growth (evolution) and decay, which are bifurcated by the critical initial mass, which depends on the temperature of CMBR.
- c) Numerically demonstrated that laminar micro-flow characteristics are significantly influenced by variable fluid properties of compressible fluid (air) [ref. 4.a.(4)]: Pressure drop (Δp) characteristics drastically differ at low Reynolds number and high heat flux than the characteristics expected for constant fluid properties. The Δp -variation in low subsonic micro-convective flow is non-linear due to temperature-sensitivity of density, rather than pressure sensitivity of density (compressibility effect). Air density [$\rho(p,T)$] and viscosity [$\mu(T)$] variations directly affect and increase the wall shear stress (τ_w), Fanning and Darcy friction factors (f_F, f_D), and Δp . Thermal conductivity and specific heat variations indirectly affect but non-negligibly decrease $\tau_w, f_F, \Delta p$, and f_D .
- d) Identified that surface radiation interchange in micro heat exchanger can improve performance [ref. 4.a.(9)]: Radiation is found to be beneficial in tubular micro heat exchanger & not parasitic as popularly known esp. in the conventionally-sized heat exchanger. Radiation makes available additional surface area for convection to the annulus flow, thereby increasing the specific heat transfer surface for fixed geometry. Hence, a high emissivity layer over the surfaces of micro heat exchanger can improve the its’ performance. The active heat transfer area weighted by the convection rates is introduced as the true measure of heat exchanger compactness.
- e) Identified another dimensionless number & geometric symmetry in annulus convection with viscous dissipation [ref. 4.a.(10)]: Nusselt and Brinkman numbers by themselves were shown to be incomplete for describing convection with viscous dissipation; therefore, another dimensionless number combining them is introduced. This number directly links convection with viscous dissipation and shrinks the complexity of mathematical analysis. When the different boundary conditions on the two annulus walls are interchanged, solution can be obtained using *reciprocal of aspect ratio of annulus* in place of *aspect ratio*, in the earlier solution. This property of mathematical solutions for annulus is termed as the *inverse aspect ratio symmetry*.
- f) Identified thermodynamic principles for dynamics of self-organisation [ref. 4.a.(12) & (34)]: Creation and existence of self-organisation or dynamic order has puzzled even pioneering scientists, because it “appears” to work against the *Entropy Principle* (EP). Known thermodynamic principles were conceptually analysed for deducing nine statements based on the broken symmetry stated by EP and the Law of Maximum Entropy Production. They serve as scale-invariant guiding principles determining

creation, existence, and destruction of dynamic ordering. Negentropy is re-defined, based on which, scale-invariant physical principles for dynamic order existence (Negentropy Principle) and evolution (Principle of Maximum Negentropy Principle: PMNEP) in chaos were identified. A universal model for dynamic ordering based on mass / energy exchange with the surroundings is introduced, which physically explains the concept of ‘*negentropy debt*’ introduced by Schroedinger. The PMNEP encompasses the basic concepts in the evolution postulates by Darwin and de Vries. Perspectives of dynamic order evolution in literature point to the validity of PMNEP as the law of evolution. Thermodynamic basis is provided for the co-existence of superior and inferior forms of dynamic order in chaos.

- g) Re-examined validity of Reynolds’ analogy for variable properties of incompressible fluid [ref. 4.a.(17)]: The inverse dependence of Reynolds number and skin friction coefficient (c_f) is found to be the starting basis for validity of the Reynolds’ analogy. This can lead to the unexpected outcome that Reynolds’ analogy now results in Stanton number *increasing* with *decreasing* c_f . A new dimensionless number is identified that correlates with the Poiseuille number, when fluid viscosity-variations are significant.
- h) Developed analytical methodology for estimation of solid-angle subtended by complex well-resolved surfaces [ref. 4.a.(20)]: This methodology is useful for quick and accurate estimation of solid-angle subtended by aircraft and rocket engine layouts, and is especially important for infrared detection studies. It is based on the *Parallel Rays Projection* method, and is accurate for large distances between IR-detector and target aircraft / missile.
- i) Identified temperature-minimised-sweepback & thermally-benign sharp Swept-Back Leading Edge (SBLE) effect in hypersonics [ref. 4.a.(27)]: It was theoretically proved that the sweepback angle at which the temperature of SBLE is minimum is not the same as drag minimised sweepback angle. The temperature minimised sweepback angle and drag minimised sweepback angles are two different concepts. Further, though blunting of leading edge is popularly believed to reduce its temperature, for SBLE this hold only up to a certain sweepback angle (Λ_{crit}). Beyond Λ_{crit} , sharper leading edge is shown to give lower temperature, which is termed as the ‘*thermally benign sharp SBLE effect*’.
- j) Identified physical effects in laminar micro-convection due to variations in incompressible [refs. 4.a.(24) & 4.a.(32)] & compressible fluid properties[ref. 4.a.(23) & 4.a.(33)]: In micro-convection, the effects of variations in properties ‘*along the flow*’ were found to be significant relative to ‘*over the cross-section*’. The induced radial flow due to fluid viscosity and density variations, modified axial convection, and induced axial conduction in fluid, were found to be important in determining micro-convection characteristics.
- k) Identified concept of undevelopment of flow in transport phenomena [ref. 4.a.(36)]: Development of flow (both thermal and hydrodynamic) is a well-known process in transport phenomena. It was identified that the reverse process also occurs in heat and momentum transport in several practical applications and in classical cases, which is termed as ‘flow-undevelopment’.

6. Other Relevant Academic & Professional Information:

a. Membership of Professional Organisations (reverse chronological order):

No.	Society / Foundation / Academy / Club	Grade	Period
i.	Institution of Engineers' (India)	Life Fellow (no. F-116247-7)	Aug'2011 - Life
ii.	Alexander von Humboldt Foundation, Germany	Life Fellow (no. INI-1104249)	Jul'2003 - Life
iii.	Indian Academy of Social Sciences	Life Fellow (no. LF/812/185/2003)	May'2003 - Life
iv.	Royal Aeronautical Society, London	Member (no. 1334074)	May'2000 - Present
v.	N.T.U. - School of Mechanical & Aerospace Engg. (M.A.E.) Graduate Research Club, Singapore	Chairman	Jan'1998 – Oct'1998
vi.	N.T.U.-M.A.E. Graduate Research Club, Singapore	Dy. Chairman & Secretary	Jan'1996 – Dec'1997
vii.	Aeronautical Society of India	Life Member (no. M.2656)	Feb'1995 – Life
viii.	Royal Aeronautical Society, London	Associate Member (no. 1334074)	Mar'1995 – Sep'1999
ix.	Royal Aeronautical Society, London	Graduate Member (no. 1334074)	Aug'1991 – Feb'1995

b. Awards / Recognitions / Honors (reverse chronological order):

- i) IIT Bombay's Review Paper Award – 2009, for: Mahulikar *et al.* 2007, Infrared signature studies of aerospace vehicles, *Prog. Aerospace Sci.* 43(7-8), 218-245.
- ii) Member of Board of Advisors, M/s IdeA Research & Development (P) Ltd. Pune, India (Apr'2009 – Mar'2011).
- iii) Member of Board of Studies for post-graduate program in Air Armament, *Defence Institute of Advanced Technology*, Pune, India (June'2008 – May'2010).
- iv) Excellence Award for 2007, from Aerospace Engg. Association, IIT Bombay (given on 4.Mar'2008).
- v) Outstanding Reviewer Award for ASME Journal of Heat Transfer (leading journal in discipline) for the yr. 2007 (given to best five reviewers on 13.Nov'2007).
- vi) A. von Humboldt Fellowship Award, F.R. Germany; 1.Jul'2003 onwards.

c. Invited Lectures in Universities / Organisations: Ref. Annexure to C.V. (2)

7. Post-Graduate Thesis Supervision:

a. Doctorate Level:

No.	Student	Title of thesis	Year of completion /In progress)	Co-guide(s)
1.	S.V. Prabhu	Entropy production in laminar micro-convective flow with variations in fluid properties	In Progress	None
2.	H. Sonawane	Infrared signature susceptibility and suppression studies of aircraft	In Progress	None
3.	N.P. Gulhane*	Studies on laminar micro-convection of liquid & gas with variations in fluid properties	2010	None
4.	G.A. Rao†	Infrared signature level studies of aircraft	2006	None

**Received:* Excellence in PhD Thesis Award from IIT Bombay. *Presently:* Assoc. Professor of Mech. Engg. @ VJTI, Mumbai, India.

†*Presently:* Asstt. Professor of Aerospace Engg. @ T.U. Delft, The Netherlands.

b. Masters' Level:

<u>No.</u>	<u>Student</u>	<u>Title of thesis</u>	<u>Completion Yr.</u>	<u>Co-guide</u>
1.	Sunita Singh	Infrared signature increment due to infrared suppression penalties	2012	–
2.	Pradeep Shende	Theoretical & numerical studies of laminar micro-convection	2012	–
3.	K.N. Yogish	Effect of surface emissivity variation on performance of micro-heat exchanger	2012	–
4.	Asgerali Masalawala	Experiments on convective flow over bent & swept cylinders	2011	–
5.	T.Y. Geril Rigzin	Estimation of bond-line between ablative & insulative thermal protection system of hypersonic vehicle	2011	–
6.	S. Vijay	Estimation of Infrared (IR) signature increment due to IR-suppressor penalties	2011	–
7.	Arun Kumar A.	Numerical study of performance of counter-flow micro-heat-exchanger with radiation	2011	–
8.	Shashank Khurana	Aero-thermal mapping of hypersonic vehicle for thermally-perfect air for TPS sizing	2008	–
9.	R.D.N. Sujatha	IR signature of aircraft structure due to aerodynamic heating & earthshine	2008	–
10.	Lavaraj C.	Conjugate CFD simulation of micro-channel cooling in gas turbine blades	2008	Prof. A.G. Marathe
11.	K. Hrisheekesh	Role of specific heat variation in laminar gas micro-convection	2007	–
12.	A. Shukla	Study of scaling effects in incompressible laminar micro convection	2007	–
13.	J.G. Soni	Experimental & numerical aerothermal studies in hypersonic flow	2007	–
14.	S.K. Potnuru	View angle assessment of aircraft susceptibility to infrared guided missiles	2007	–
15.	S. Degwekar	Experimental investigation of convective heat transfer to hypersonic vehicle geometries	2006	–
16.	D.Y. Kulkarni	Modelling of contoured squeeze film damper with turbulence for rotor dynamic application	2006	Prof. R.W. Shende
17.	P.S. Kolhe	Prediction of aircraft rear fuselage temperature for IR signature studies	2003	–
18.	Sqn. Ldr. R.	IR signature level studies of heated aerospace	2003	–

	Mongia	structures		
<u>No.</u>	<u>Student</u>	<u>Title of thesis</u>	<u>Completion Yr.</u>	<u>Co-guide</u>
19.	H.S.S. Prasad	IR signature suppression system for helicopter	2003	–
20.	S.G. Shevakari	Aerothermal mapping of Hypersonic Reusable Vehicle (HRV) for thermally-perfect air	2003	–
21.	R. Dungarwal	Aerothermal mapping of HRV for calorically perfect air	2002	–

8.(a) Classroom Teaching at IIT-Bombay, India: Aerospace Heat Transfer (UG & PG[†]), Aircraft Propulsion (UG & PG), Communication & Leadership (PG), Heat Transfer - Fundamentals (UG), Spaceflight Mechanics (UG), Aerospace Thermodynamics (UG).

Introduced the following experiments in Propulsion Laboratory curriculum (UG & PG):

- i) Study of convective heat transfer to bent cylinder (bi-curvature forward stagnation region),*
- ii) Study of convective heat transfer to swept-cylinder.*

8.(b) Classroom Teaching at T.U. Hamburg-Harburg, Germany (as DFG-Mercator Professor): Special Topics in Thermodynamics & Heat Transfer (PG)

8.(c) Imp. Administrative Activities at IIT-Bombay:

- i) Member of Aerospace Dept. PG Committee = Jan'2002 – Jun'2003 & Sep'2004 – Jun'2007;*
- ii) Member of Aerospace Dept. UG Committee = Jun'2008 – Nov'2011*
- iii) PG-Admissions Coordinator of Aerospace Dept. = Feb-Nov'2011*

[†] UG: Under-Graduate Level, PG: Post-Graduate Level

9. Sponsored & Consultancy Research Projects Undertaken as Principal Investigator:

<u>Sponsoring Agency</u>	<u>Title of Project</u>	<u>Amount of Grant (INR)*</u>	<u>Period</u>	<u>Co-investigators</u>
Industrial Research & Consultancy Centre (IRCC), IIT-Bombay, India (Rev. Paper Award 2009 Project)	(i) Theoretical & numerical studies on IR signatures of aerospace vehicles; (ii) Theoretical & numerical studies on laminar micro-convection	495,000.00	2010-14	None
Gas Turbine Research Establishment, Bangalore, India	Audit of thermal design of Hindustan Aeronautics Ltd.'s Digital Electronic Control Unit (Consultancy mode)	57,500.00	2002	Prof. S.K. Sane & A.G. Marathe
Rotary Wing Research & Design Centre, Hindustan Aeronautics Ltd. Bangalore, India	Development of indigenous infrared signature suppressor for engine exhaust duct of Advanced Light Helicopter (Consultancy mode)	460,000.00	2001-09	Prof. S.K. Sane – Caretaker during Humboldt Fellowship's 1 st Term
Aeronautics Research & Devpt. Board (ARDB, Aerodynamics Panel), India	Analytical solution for Nusselt number in laminar annular flows with viscous dissipation term	244,000.00	2001-03	Prof. A.G. Marathe – Caretaker during Humboldt Fellowship's 1 st Term
Defence Research & Development Lab. Hyderabad, India	Aerothermal studies in hypersonic flows for reusable hypersonic vehicle	499,000.00	2001-03	Prof. A.G. Marathe – Caretaker during Humboldt Fellowship's 1 st Term
ARDB (Propulsion Panel), India	Infrared signature level studies of military aircraft	297,200.00	2001-03	Prof. A.G. Marathe – Caretaker during Humboldt Fellowship's 1 st Term
IRCC (Seed Grant), IIT Bombay, India	Investigation of calibration non-linearity and pressure loss characteristics of ball-in-vortex flow-meter	50,000.00	2000-01	Prof. S.K. Sane

*The above grant amount (in Indian Rupees) is for theoretical & numerical / academic research projects and does not include amount to support postgraduate (Masters' & PhD) students.

- 1) Amount of grant (no. 1104249/INI) received from A. von Humboldt Foundation, Germany = € 42,000.00
- 2) Amount of grant received Visiting Professorship programme of Helsinki University of Technology, Finland = € 12,000.00
- 3) Amount of grant (no. 2008-607) received from Foreign Experts' Program for Scientific Research, Zhejiang Province, P.R. China = US\$ 5,000.00
- 4) Amount of grant (no. 2009-0094016) received from Priority Research Centers Program, National Research Foundation, S. Korea = US\$ 12,000.00
- 5) Amount of grant (no. T-ZW-M21-DFG-1131) received from DFG's Mercator Professorship programme, Germany = € 80,000.00

10. Salient features in extra-curricular activities (Public-Speaking):

<u>No.</u>	<u>Event</u>	<u>Date</u>	<u>Contribution</u>
i.	Institution of Engineers' - Singapore, Toastmasters' Speech Contest	8.Dec'1998	Champion
ii.	Area-D ₄ International Speech Contest	5.Feb'1999	Champion
iii.	Division-D International Speech Contest	20.Mar'1999	1 st runner-up
iv.	Institution of Engineers' - Singapore, Toastmasters' Speech Contest	15.Dec'1999	1 st runner-up
v.	Speech-craft Programme of Nanyang Business School (N.B.S.) Toastmasters Club - Singapore	1.Feb – 18.Feb'1999	Asstt. Prog. Coordinator
vi.	N.B.S. Toastmasters Club - Singapore	Jul'1999 – 21.Jan'2000	Advisor

Annexure to C.V:

(1) Conference Publications (reverse chronological order)

- 1] **Mahulikar, S.P.**, Gulhane, N.P., Pradhan, S.D., & Prabhu, S.V., 2011 (Jul), Keynote Lect. 'Pressure drop in laminar micro-convective flow due to variable properties of compressible fluid', 7th *International Conference on Computational Heat and Mass Transfer*, Istanbul, Turkey.
- 2] **Mahulikar, S.P.**, Rao, G.A., Sonawane, H.R., & Prasad, H.S.S., 2009 (Aug), *Invited paper: Infrared Signature Studies of Aircraft and Helicopters* (pap. no. 090107203540), *Proceedings of Progress in Electromagnetics Research Symposium (PIERS-2009)*, Moscow.
- 3] **Mahulikar, S.P.**, & Herwig, H., 2008 (Jun-Jul), *Invited paper: Fluid property variations in micro-convection*, *Proceedings of 8th World Congress on Computational Mechanics*, Venice, Italy; in: *Advances in multiphysics simulation & experimental testing of MEMS & NEMS* (ID: 151), ed. A. Frangi, N. Aluru, S. Mukherjee.
- 4] **Mahulikar, S.P.**, Rao, G.A., Sonawane, H.R., Potnuru, S.K., Kolhe, P.S., & Prasad, H.S.S., 2008 (Jun), *Invited Lecture (IT-9): Infrared signature studies of airborne targets*, *Proceedings of International Conference on Aerospace Science & Technology*, Bangalore, India.
- 5] **Mahulikar, S.P.**, & Herwig, H., 2005 (Jun), Modified thermodynamic principles unifying order existence and evolution, *Proceedings of 18th International Conference on Efficiency, Cost, Optimization, Simulation, and Environmental Impact of Energy Systems (ECOS)*, Trondheim, Norway; ed. S. Kjelstrup, J.E. Hustad, T. Gundersen, A. Røsjorde, G. Tsatsaronis (Tapir Uttrykk, Norway), pp. 295-302.
- 6] Herwig, H., & **Mahulikar, S.P.**, 2005 (Jun), Variable property effects in single-phase incompressible flows through micro-tubes, *Proceedings of 3rd International Conference on Microchannels & Minichannels*, Toronto, Canada, Pap. no. ICMM 2005-75082.
- 7] **Mahulikar, S.P.**, Herwig, H., Hausner, O., & Kock, F., 2005 (May), Scaling effects in continuum-based laminar gas micro-flow convection due to variation of gas properties, 4th *International Conference on Computational Heat and Mass Transfer*, Paris-Cachan, France, ed. R. Bennacer, A.A. Mohamad, M.ElGanaoui, J. Sicard (Lavoisier, France), Pap. no. 120.
- 8] Rao, G.A., & **Mahulikar, S.P.**, 2005 (Jan), Aircraft powerplant and plume infrared signature modeling and Analysis, 43rd *AIAA Aerospace Sciences Meeting and Exhibits*, Reno Nevada, U.S.A., AIAA-2005-0221 (with PhD student).
- 9] Rao, G.A., & **Mahulikar, S.P.**, 2004 (Nov), Review of stealth technology and aircraft IR signatures, *Proceedings of 7th National Conference on Air Breathing Engines and Aerospace Propulsion*, IIT-Kanpur, India, pp. 345-358.
- 10] **Mahulikar, S.P.**, Herwig, H., & Hausner, O., 2004 (Mar), Numerical simulation of 1-D incompressible laminar microscale convection behaviour with temperature dependent fluid properties, *Proceedings of Applied Mathematics & Mechanics (GAMM-2004 Conference, Dresden, Germany)*, Vol. 4, No. 1, pp. 488-489.
- 11] **Mahulikar, S.P.**, Herwig, H., & Hausner, O., 2003 (Sep), Identification of critical scope: comprehensive review of microscale convection, *Collection of Papers: 9th International Workshop on Thermal Investigations of ICs & Systems*, Aix-en-Provence, France (TIMA Lab, Grenoble, France), pp. 7-30.
- 12] **Mahulikar, S.P.**, 2003 (Jun), *Invited paper: New analyses and concepts for aerodynamic heating to critical surfaces of hypersonic vehicle*, *Proceedings of Confederation of European Aerospace Societies: Aerospace Aerodynamics Research Conference*, London, U.K., pp. 20.1-20.12.
- 13] **Mahulikar, S.P.**, 2003 (Feb), Stealth technology and its' role in current geopolitics, *Proceedings of XXVI Indian Social Science Congress*, Andhra University, Visakhapatnam, India (invited lecture).
- 14] **Mahulikar, S.P.**, & Dungarwal, R., 2002 (Aug), Numerical simulation of forward stagnation region temperature field of reusable hypersonic vehicle, *Proceedings of 5th Annual CFD Symposium*, Bangalore, India, CP-23.
- 15] **Mahulikar, S.P.**, 2002 (Feb), High performance cooling using microchannels for coming generation applications, *Proceedings of DRDO Workshop on Propulsion Systems*, HEMRL-Pune, India, pp. 159-168 (invited paper).

- 16] **Mahulikar, S.P.**, Sane, S.K., & Marathe, A.G., 2002 (Jan), Analysis of thermo-fluid issues in fuel cooling of electronics in aircraft, *Proceedings of International Symposium on Recent Trends in Heat & Mass Transfer*, IIT-Guwahati, India, Pap. no. ISRTHMT 02-126.
- 17] Sane, S.K., **Mahulikar, S.P.**, Marathe, A.G., & Jha, A.K., 2000 (Sep), Analytical investigation of calibration non-linearity of ball-in-vortex flowmeter, *Proceedings of Global Conference on Flowmetering & Control for New Millennium*, Palakkad-Kerala, India, pp. 127-134.
- 18] Tso, C.P., & **Mahulikar, S.P.**, 1999 (Oct), A survey on coupled transport processes in thin liquid films for microchannel heat transfer application, *Collection of Papers: 5th International Workshop on Thermal Investigations of ICs & Microstructures*, Rome-Italy (TIMA Lab, Grenoble, France), pp. 56-62 (from PhD Thesis).
- 19] Tso, C.P., & **Mahulikar, S.P.**, 1999 (Jun), Multimode heat transfer in a two-dimensional microchannel, *Proceedings of Pacific Rim / ASME International, Intersociety Electronic Packaging Conference*, Maui-Hawaii, USA (ASME, USA), Vol. 26-2, pp. 1229-1233 (from PhD Thesis).
- 20] Tso, C.P., & **Mahulikar, S.P.**, 1998 (Dec), Laminar convection behaviour in microchannels in conventional thermal entry length & beyond, *Proceedings of IEEE's 2nd Electronics Packaging Technology Conference*, Singapore (IEEE, Piscataway, NJ, USA), pp. 126-132 (from PhD Thesis).
- 21] Tso, C.P., & **Mahulikar, S.P.**, 1998 (Sep), Numerical simulation of coupled flow & evaporating meniscus-driven convection in annular microchannels, *Proceedings of 3rd High Performance Computing Asia Conference*, Singapore, pp. 732-739 (from PhD Thesis).
- 22] Tso, C.P., & **Mahulikar, S.P.**, 1997 (Dec), Semi-analytical study of coupled heat transfer & flow due to evaporating meniscus in annular microchannels for electronics cooling, *Proceedings of 2nd International Seminar on Fluid Mechanics & Heat Transfer*, Dhaka-Bangladesh, pp. 9-16 (from PhD Thesis).
- 23] Tso, C.P., & **Mahulikar, S.P.**, 1997 (Dec), Coupled fluid flow & heat transfer due to an evaporating meniscus in annular microchannels, *Proceedings of 7th Asian Congress of Fluid Mechanics*, Chennai (Madras)-India, pp. 757-760 (from PhD Thesis).
- 24] **Mahulikar, S.P.**, 1993 (Apr), Prediction of transmissivity of the intervening atmosphere for infrared signature studies, *SAE's Aerospace Atlantic Conference*, Dayton-Ohio, USA (SAE, Warrendale, PA, USA), SAE Technical Pap. no. 931413.
- 25] **Mahulikar, S.P.**, 1992 (Apr), Prediction of engine casing temperature of fighter aircraft for infrared signature studies, *SAE's Aerospace Atlantic Conference*, Dayton-Ohio, USA (SAE, Warrendale, PA, USA), SAE Technical Pap. no. 920961(1-10).
- 26] **Mahulikar, S.P.**, 1992 (Apr), Philosophical approach to the basic understanding of the mechanics of jet propulsion, *SAE's Aerospace Atlantic Conference*, Dayton-Ohio, USA (SAE, Warrendale, PA, USA), SAE Technical Pap. no. 920960(1-7).

(2) Invited Lectures in Universities / Research Organisations (reverse chronological order)

<u>Lecture Title</u>	<u>University / Organisation</u>	<u>Date</u>
Infrared (IR) signature studies of aerospace vehicles	Bilkent Univ. Ankara, Turkey	Sep'2012
Role of surface radiative transfer in co-current microheat exchanger	Arçelik A.Ş. R&D Center, Istanbul, Turkey	Sep'2012
Thermodynamic principles for self-organisation in embedding isolated systems	Institute for Social & Economic Change, Bangalore, India	Oct'2011
Role of thermodynamics in dynamic ordering / Pressure drop in laminar micro-convective flow	Indian Institute of Technology Mandi, Himachal Pradesh, India	Sep'2011
Laminar micro-convective flow characteristics due to variable properties of compressible fluid	Istanbul Technical Univ. Turkey	Jul'2011
Role of thermodynamics in dynamic ordering	Indian Institute of Astrophysics Bangalore, India	Feb'2011
IR signature studies of aerospace vehicles	Gyeongsang National Univ. Jinju, S. Korea	Dec & Jun 2010
IR signature suppression studies	Defence Lab. Jodhpur, India	Nov'2010, Nov'2008

<u>Lecture Title</u>	<u>University / Organisation</u>	<u>Date</u>
Investigation on infrared (IR) signatures of aircraft & helicopters	Yonsei Univ. Seoul, S. Korea	Jun 2010
Role of thermodynamics in ordering / Laminar micro-convection with fluid property variations	Institut National des Sciences Appliquées de Toulouse, France	Jun'2009
Exact thermodynamic principles for dynamic order existence and evolution in chaos	Delft University of Technology, The Netherlands (Fac. Aerospace Engg.)	Jun'2009
Role of thermodynamics in dynamic ordering / Laminar micro-convection with incompressible fluid property variations	Vienna University of Technology, Austria (Institute of Fluid Mechanics & Heat Transfer)	May'2009 / Mar'2004
Role of thermodynamics in dynamic order existence and evolution	Technische Universität Hamburg-Harburg, Germany	May'2009
Investigation on infrared (IR) signatures of aircraft & helicopters	Aeronautical Development Agency, Bangalore, India	Jan 2009
Thermodynamics in dynamic ordering / Fluid property variations in micro-convective flows	China Jiliang Univ. / Zhejiang Univ. P.R. China	Dec'2008 / Jun'2005
Infrared signatures of aircraft & naval vessels	Naval Science & Technological Lab. Visakhapatnam, India	Nov'2008
Infrared signature studies of aerospace vehicles	Defence Institute of Advanced Technology, Pune, India	Aug'2008
Role of variations in gas properties on laminar micro-convection characteristics	Università di Bologna, Italy	Jul'2008
Role of thermodynamics in dynamic ordering	Univ. Washington (Seattle), U.S.A.	Nov'2007
Thermodynamics in dynamic ordering / Physical mechanisms in micro-convection due to variations in fluid properties	National Univ. Singapore	Sep'2007
Role of thermodynamics in dynamic order existence and evolution / Fluid property variations in micro-convective flows	Helsinki Univ. Technology, Finland	May'2006
Overview of micro-flow convection research & identification of critical research scope	Technische Universität Chemnitz, Germany (Maschinenbau und Verfahrenstechnik)	Nov'2003
Overview of IR signature camouflage of aircraft	Instruments Research & Development Lab. Dehradun, India	Apr'2002
IR signature reduction of existing engine airframe integrations	Air Headquarters, New Delhi, India	Oct'2001
IR signature suppression of military helicopters	RWR&DC, Hindustan Aeronautics Ltd. Bangalore, India	Jan'2001
Role of Brinkman number in laminar microscale convection	Indian Navy Ship Shivaji, Lonavla, India	Mar'2000