

Paola Brocca

Associate professor of Applied Physics at the University of Milan and member of the Department of Medical Biotechnologies and Translational Medicine.

Present address

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PROFESSIONAL EMPLOYMENT

2010- Associate professor of Applied Physics, University of Milan

2002- Researcher of Applied Physics, University of Milan

1996 Research Fellow for HCM European Project "Solubilization and Interfacial Properties of Surfactant Solutions" at the "Centre a l'Energie Atomique (CEA)", Saclay (FR)

1995/01 Technician responsible of High Resolution NMR and Molecular Modeling laboratories at Dept Chemistry, Biochemistry and Biotechnologies l'Università degli Studi di Milano.

1994 Research fellow at the "Departement de Recherche sur l'Etat Condensé, les Atomes et les Molécules" (DRECAM) du Centre a l'Energie Atomique (CEA) - Saclay (FR).

1992/93 Research fellow Department of Chemistry Biochemistry and Biotechnology, University of Milan

TEACHING

2013-19 Medical Physics, School of Medicine

2018-19 Mathematics, Technical Degree in Radiology

2003-18 Applied Physics, School of Sport Science

2013-15 Applied Physics, Degree in Orthopedics

2011-13 Applied Physics, Degree in Audiology

2001-03 Applied Physics, Degree in Speech Therapy

RESEARCH ACTIVITY

Her research interest is within the field of the biological soft matter. Scattering techniques, light, X-ray and neutron, together with DSC and modulated DSC calorimetry, densitometry and high resolution NMR, are applied to the structural and dynamical investigation of nano-system of biological or pharmacological relevance. The parallel use of different spectroscopic techniques allows to cover a wide range of time and lengths scale, providing a comprehensive study of soft colloidal systems. Beside those activities she is involved in the development of a differential interferometric techniques to study air-liquid and liquid-liquid interfaces of nanometer-distance oscillating bubbles and drops, sensing charge and surface tension.

Long term topics

— *Colloidal phases of glycolipids and phospholipids.*

- *Micelles, Vesicle, supported and floating Bilayer as model membrane.*
- *Nanocarriers for drug delivery and gene transport.*

Specific topics

- Optical Interferometry on Bubble and Drops to study the charge and tension of air-liquid and liquid-liquid interfaces loaded with biosurfactant, globular proteins and channel proteins.
- Biological gels and mucopenetrating nanovectors in treatment of Cystic Fibrosis.
- Biological material interactions with bio-inspired polymers

GRANT INVOLVEMENT

FFC Grant 2018, pilot project titled "*Enabling pulmonary delivery of siRNA in cystic fibrosis lung inflammation: therapeutic potential of hybrid lipid/polymer nanoparticles*"

BioMeTra Department Grant 2017 titled "*Nanomedicine development in Cystic Fibrosis lung disease: in vitro model for siRNA delivery through the airway barrier*"

ERC Grant noMAGIC 2017 to Anna Moroni and Gerhard Thiel titled "*Ion channel design using experimental and computational inputs*"

FIRB - PROGRAMMA "FUTURO IN RICERCA" RBFR08QIP5 '*Comprensione delle Interazioni tra Cellule e Nanoparticelle Lipidiche per il Trasporto Genico*'.

PRIN 2004024358: "Processi dinamici in strutture organizzate di sistemi saccaridici in solvente acquoso"

FIRB strategico Nuova Ingegneria Medica (RBNE01XPYH)

FIRB strategico Neuroscienze (RBNE012LW8)

European grant HCM (ERBCHRXCT920019) "Solubilization and Interfacial Properties of Surfactant Solutions".

PUBLICATIONS

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- 1) P.Brocca, D.Acquotti and S.Sonnino. ^1H -NMR study on ganglioside amide protons: evidence that the deuterium exchange kinetics are affected by the preparation of samples. *Glycoconjugate J* 10, 441-446,1993.
 - 2) S.Sonnino, D.Acquotti, P.Brocca, L.Cantù and M.Corti. Influence of the primary and secondary structure of the oligosaccharide chain on the aggregative and geometrical properties of gangliosides. *Indian J Biochem Biophys* 30, 370-375, 1993.
 - 3) D.Acquotti, F.Bonomi, P.Brocca, M.L.Ganadu and S.Pagani. Some structural features of cluster-coordinating cysteines of *Clostridium Pasteurianum* ferodoxin are revealed by 2D Tocsy ^1H NMR on the oxidized protein. *Biochem Biophys Res Commun* 202, 591-595, 1994.
 - 4) P.Brocca, L.Cantù and S.Sonnino. Aggregation properties of semisynthetic GD1a ganglioside (IV³Neu5AcII³Neu5AcGgOse₄Cer) containing an acetyl group as acyl moiety. *Chem. Phys Lipids* 77, 41-49,1995.
 - 5) R.Casellato, P.Brocca, S.-C.Li, Y.-T.Li and S.Sonnino. Isolation and Structural Characterization of N-Acetyl- and N-Glycolyneuraminic acid containing GalNAc-G_{D1a} isomers, IV⁴GalNAcIV³Neu5AcII³Neu5GcGgOse₄Cer and

- IV⁴GalNAcIV³Neu5GcII³Neu5AcGgOse₄Cer, from bovine brain. *Eur J Biochem* 263, 1208-1215,1995.
- 6) P.Brocca, D.Acquotti and S.Sonnino. Nuclear Overhauser effect investigation on GM₁ ganglioside containing *N*-Glycolyl-Neuraminic acid (II³Neu5GcGgOse₄Cer). *Glycoconjugate J* 13, 57-62, 1996.
 - 7) V.Chigorno, C. Riva, M. Valsecchi, M. Nicolini, P. Brocca and S. Sonnino. Metabolic processing of gangliosides by human fibroblasts in culture. The re-cycling of long chain bases. *Eur J Biochem* 250, 661-669, 1997.
 - 8) P.Brocca, P.Berthault and S.Sonnino. Conformation of the oligosaccharide chain of GM1 ganglioside, in a carbohydrate enriched surface. *Biophysical J* 74, 309-318, 1998.
 - 9) P.Brocca and S. Sonnino. Dynamics and spatial organization of surface gangliosides. Invited Minireview *Trends in Glycoscience and Glycotechnology* 433-445,1998.
 - 10) A.Bernardi, A.Checchia, P.Brocca, S.Sonnino and F.Zuccotto Sugar mimics: An artificial receptor for cholera toxin. *Journal of the American Chemical Society* 121(10), 2032-2036, 1999.
 - 11) SC. Li, YT. Li, A. Hasegawa, H. Ishida, M. Kiso, A. Bernardi, P. Brocca, L. Raimondi, S. Sonnino. Structural basis for the resistance of Tay-Sachs ganglioside GM2 to enzymatic degradation. *Journal of Biological Chemistry*. 274(15),10014-10018, 1999
 - 12) S. Sonnino, P. Brocca, D. Acquotti, A. Bernardi, L. Raimondi, M. Kiso, H. Ishida, YT. Li, SC. Li The structural basis for the susceptibility of gangliosides to enzymatic degradation. *Bioscience Reports*. 19(3), 163-168, 1999.
 - 13) P. Brocca, A. Bernardi, L. Raimondi, S. Sonnino. Modeling ganglioside headgroups by conformational analysis and molecular dynamics. *Glycoconjugate Journal*. 17(5), 283-299, 2000.
 - 14) P. Brocca, L. Cantù, M. Corti, E. Del Favero. Thermal fluctuations of small vesicles: observation by light scattering. *Progr Colloid Polym Sci* 115,181-185, 2000
 - 15) P. Brocca, L. Cantù, M. Corti, E. Del Favero, A. Raudino. Collective phenomena in confined micellar systems of ganglioside. *Physica A* 304, 177-190, 2002
 - 16) P. Brocca, L. Cantù, M. Corti, E. Del Favero, A. Raudino . Cooperative Behaviour of Ganglioside Molecules in Model Systems, *Neurochemical Research*, 27, 559-563, 2002
 - 17) P. Brocca, L. Cantù, M. Corti, E. Del Favero. Aggregation preoperties and Phase Behavior of Biological Amphiphiles with large saccharidic headgroup. In *Massa Marittima 2002 IOS publisher*
 - 18) P. Brocca, L. Cantù, M. Corti, E. Del Favero, S Motta. Shape fluctuations of large unilamellar vesicles observed by light scattering: Influence of the Small-Scale Structure. *Langmuir* 20 (6), 2141-2148, 2004
 - 19) P. Brocca, L. Cantù, F. Cavatorta, M. Corti, E. Del Favero , A. Deriu, M. Di Bari, Dynamics of ganglioside micellar solution by quasielastic neutron scattering. *Physica B* 350, e619-e622, 2004.
 - 20) Sega, M.; Vallauri, R.; Brocca, P. and Melchionna S. Molecular dynamics simulation of a GM3 ganglioside bilayer. *Journal of Physical Chemistry B* 108, (52), 20322-30, 2004
 - 21) Brocca, P.; Cantu, L.; Del Favero, E.; Dubois, M.; Motta, S.; Tunesi, S.; Zemb, Th. Headgroup and chain melting transition in dispersed bilayers of GM3 ganglioside. *Colloids and Surfaces, A: Physicochemical and Engineering Aspects*, 259(1-3), 125-133, 2005.
 - 22) P.Brocca, L.Cantù, M.Corti, E.Del Favero, S.Motta, M.C.Nodari. Curved Single-Bilayers in the Region of the Anomalous Swelling: Effect of Curvature and Chain Length. *Coll.Surf.A* 291(1-3) (2006) 63-68.
 - 23) P. Brocca, L. Cantù, M. Corti, E. Del Favero, A. Raudino. Intermicellar interactions may induce anomalous size behaviour in micelles carrying out bulky heads with multiple spatial arrangements. *Langmuir* 23(6) (2007) 3067-3074.

- 24) M.Sega, G.Garberoglio, P.Brocca, L.Cantù. Microscopic structure of phospholipid bilayers: comparison between molecular dynamics simulations and wide angle X-ray spectra. *J.Phys.Chem. B* 111 (2007), 2484-2489.
- 25) P.Brocca, L.Cantù, M.Corti, E.Del Favero, S.Motta, M.C.Nodari. DC₁₃PC Bilayers from Anomalous Swelling to Main Transition: an X-ray Scattering Investigation. *J.Coll.Int.Sci.* 312 (2007) 34-41.
- 26) M. Corti, L. Cantù, P. Brocca E. Del Favero. Self-assembly in glycolipids. *Curr.Op.Coll.Int.Sci.* 12 (2007) 148-154.
- 27) E.Del Favero,P. Brocca, L. Cantù, M. Corti, A. Raudino. Anomalous phase behaviour of glycolipids self-assembly tuned by sugar headgroup surface arrangement. *Eur Biophys J* 36 (Suppl 1) S111 2007
- 28) P. Brocca, L. Cantù, E.Del Favero, M. Corti, S. Motta, C Nodari. From anomalous Swelling to Main Transition: the DC13PC Bilayers. *Eur Biophys J* 36 (Suppl 1) S58 2007
- 29) M.Sega, R.Vallauri, P.Brocca, L.Cantù, S.Melchionna. Short range structure of a GM3 ganglioside membrane: comparison between experimental WAXS and computer simulation results. *J.Phys.Chem.B* 111 (2007) 10965-10969.
- 30) Y Gerelli, S Barbieri, MT Di Bari, A Deriu, L Cantù, P Brocca, F Sonvico, P Colombo, R May, S Motta. Structure of self-organized multilayer nanoparticles for drug delivery. *Langmuir* 24(20) (2008) 11378-11384.
- 31) S. Motta, A. Raudino, P. Brocca, M. Corti, L. Cantu', E. Del Favero. Hierarchical Ordering of Sugar Based Amphiphiles. *Mol Cryst Liq Cryst* 500 (2009) 155-165.
- 32) L. Cantu', M Corti, P Brocca, E Del Favero. Structural aspects of ganglioside-containing membranes. *Biochim Biophys Acta* 1788 (2009) 202–208.
- 33) L. Cantù, E. Del Favero, A. Raudino, G. Fragneto, P. Brocca, S. Motta. Lamellar stacking split by in membrane clustering of bulky glycolipids. *Langmuir* 25 (2009) 4190-4197
- 34) E. Del Favero, P. Brocca, S. Motta, V. Rondelli, S. Sonnino and L. Cantu'. Nanoscale structural response of ganglioside-containing aggregates to the interaction with sialidase. *Journal of Neurochemistry* 116 (2011) 833-839.
- 35) E.Del Favero, A.Raudino, M.Pannuzzo, P.Brocca, S.Motta, L.Cantu'. Transient step-like kinetics of enzyme reaction on fragmented-condensed micellar substrates. *J. Phys. Chem. B* 116 (2012) 9570–9579.
- 36) V.Rondelli, G.Fragneto, S.Motta, E.Del Favero, P.Brocca, S.Sonnino, L.Cantu'. Ganglioside GM1 forces the redistribution of cholesterol in a biomimetic membrane. *Biochimica et Biophysica Acta* 1818 (2012) 2860–2867.
- 37) S.Motta, P.Brocca, E.Del Favero, V.Rondelli, L.Cantu', A.Amici, D.Pozzi, G.Caracciolo. Nanoscale structure of protamine/DNA complexes for gene delivery. *Appl. Phys. Lett.* 102, 053703 (2013); doi: 10.1063/1.4790588.
- 38) V.Rondelli, E.Del Favero, S. Motta, L.Cantu, G. Fragneto, P.Brocca. Neutrons for rafts, rafts for neutrons. *Eur. Phys. J. E* (2013) 36: 73. (DOI 10.1140/epje/i2013-13073-4)
- 39) D.Pozzi, C.Marchini, F.Cardarelli, A.Rossetta, V.Colapicchioni, A.Amici, M.Montani, S.Motta, P.Brocca, L.Cantu', G.Caracciolo. Mechanistic Understanding of Gene Delivery Mediated by Highly Efficient Multicomponent Envelope-Type Nanoparticle Systems. *Mol. Pharmaceutics* 10 (2013) 4654–4665 DOI 10.1021/mp400470p
- 40) L.Cantu', E.Del Favero, P.Brocca, M.Corti, Multilevel structuring of ganglioside-containing aggregates: from simple micelles to complex biomimetic membranes. *Advances in Colloid and Interface Science* 205 (2014) 177–186.
- 41) E.Del Favero, P.Brocca, V.Rondelli, S.Motta, A.Raudino, L.Cantu'. Optimizing the crowding strategy: sugar-based ionic micelles in the dilute-to-condensed regime. *Langmuir* 30(30) (2014) 9157–9164. DOI: 10.1021/la501963y
- 42) A.De Luigi, A.Mariani, M.De Paola, A.Re Depaolini, L.Colombo, L.Russo, V.Rondelli,

- P.Brocca, L.Adler-Abramovich, E.Gazit, E.Del Favero, L.Cantu' and M. Salmona. Doxycycline hinders phenylalanine fibril assemblies revealing a potential novel therapeutic approach in phenylketonuria. *Sci.Reports* (2015), 5, 15902, doi:10.1038/srep15902.
- 43) C.Marianecchi, L.Di Marzio, E.Del Favero, L.Cantu', P.Brocca, F.Rinaldi, L.Dini, D.Man.Serra, S.Esposito, P.Decuzzi, C.Celia, D.Paolino, M.Fresta, M.Carafa. Niosomes as drug nanovectors: multiscale pH-dependent structural response. *Langmuir* (2016) 32, 12411249.
- 44) S.Motta, V.Rondelli, L.Cantu', E.Del Favero, M.Aureli, D.Pozzi, G.Caracciolo, P.Brocca. What the cell surface does not see: the gene vector under the protein corona. *Colloids and Surfaces B: Biointerfaces* (2016) 141, 170–178.
- 45) V.Rondelli, P.Brocca, S.Motta, M.Messa, L.Colombo, M.Salmona, G.Fragneto, L.Cantu', E.Del Favero. Amyloid- β Peptides in interaction with raft-mime model membranes: a Neutron Reflectivity insight. *Nature Sci.Reports* 6, 20997 (2016) DOI: 10.1038/srep20997
- 46) B.Aoun, E.Pellegrini, M.Trapp, F.Natali, L.Cantu', P.Brocca, Y.Gerelli, B.Demé, M.M.Koza, M.Johnson, J. Peters. Direct comparison of elastic incoherent neutron scattering experiments with molecular dynamics simulations of DMPC phase transitions. *EPJ* (2016) *Eur.Phys.J. E* (2016) 39: 48. DOI 10.1140/epje/i2016-16048-y
- 47) P.Brocca, V.Rondelli, F.Mallamace, M.T.Di Bari, A.Deriu, W.Lohstroh, E.Del Favero, M.Corti, L.Cantu'. Water Response To Ganglioside GM1 Surface Remodelling, *BBA* (2016) BBAGEN-16-48R1.
- 48) G.Sandri, S.Motta, M.C.Bonferoni, P.Brocca, S.Rossi, F.Ferrari, V.Rondelli, L.Cantu', C. Caramella, E.Del Favero. Chitosan-coupled Solid Lipid Nanoparticles: tuning nanostructure and mucoadhesion (2016) *European Journal of Pharmaceutics and Biopharmaceutics*, (2016) 110, 13–18.
- 49) V.Rondelli, P.Brocca, G.Fragneto, J.Daillant, C.Tringali, L.Cantu', E.Del Favero. In situ digestion of gangliosides by sialidase induces surface restructuring in raft-mime membranes: a Synchrotron X-Ray reflectivity insight. *BBA Biomembranes* (2017) 1859(5) 845-851.
- 50) L.Colombo, A.Gamba, L.Cantu', M.Salmona, F.Tagliavini, V.Rondelli, E.Del Favero, P.Brocca. Pathogenic A β A2V versus protective A β A2T mutation: early stage aggregation and membrane interaction. *Biophysical Chemistry* (2017), <http://dx.doi.org/10.1016/j.bpc.2017.05.001>
- 51) V.Rondelli, P.Brocca, N.Tranquilli, G.Fragneto, E.Del Favero, L.Cantu'. Building a biomimetic membrane for neutron reflectivity investigation: Complexity, asymmetry and contrast. *Biophysical Chemistry* (2017), doi: 10.1016/j.bpc.2017.04.011
- 52) E.Del Favero, P.Brocca, L.Cantu', Scattering techniques and ganglioside aggregates: laser light, neutron and X-ray scattering. *Methods in Molecular Biology*, (Clifton, N.J.). In book: *Gangliosides*, (June 2018) 1804:57-82 DOI:10.1007/978-1-4939-8552-4_3
- 53) V.Rondelli, E.Del Favero, P.Brocca, G.Fragneto, M.Trapp, L.Mauri, M.G.Ciampa, G.Romani, C.J.Braun, L.Winterstein, I.Schroeder, G.Thiel, A. Moroni, L. Cantu'. Directional K⁺ channel insertion in a single phospholipid bilayer: Neutron reflectometry and electrophysiology in the joint exploration of a model membrane functional platform. *BBA - General Subjects* 1862 (2018) 1742–1750. doi:10.1016/j.bbagen.2018.05.007
- 54) Brocca P., Rondelli V., Corti M., Del Favero E., Deleu M., Cantu' L., Interferometric investigation of the gas-phase monolayer of mono-rhamnolipid adsorbing at an oil/water interface. *J.Mol.Liquids* (2018) 266, 687–691.