

# Mihnea Colţoiu

## Education:

- 1974-1979 student, Faculty of Mathematics, University of Bucharest
- 1985 Ph.D. at IMAR. Thesis: Convexity in Complex Analysis, advisor C. Bănică.

## Academic positions:

- 1979-1990 scientific researcher at IMAR
- 1990-1993 principal researcher II at IMAR
- 1993-present principal researcher I la IMAR

Since 1992 is the leader of Complex Analysis and Potential theory work-group at IMAR.

Since March 2006 is a corresponding member of the Romanian Academy, Mathematics Section.

## Awards:

- 1987 S. Stoilow Prize of the Romanian Academy
- 2000 ANSTI gold medal

M. Colţoiu works on problems in analytic pseudoconvexity, especially in Stein spaces,  $q$ -convexity and  $q$ -concavity. This type of problems have strong connections with algebraic topology, algebraic geometry, singularity theory. Several of his papers are cited in Encyclopaedia of Mathematical Sciences, 74, Springer Verlag 1994, in Developments of Mathematics 1950-2000 (Birkhäuser 2000), and several other monographs such as: X. Ma, G. Marinescu: Holomorphic Morse inequalities and Bergman kernels. Birkhuser, 2007, M. Klimek: Pluripotential theory. Oxford University Press, 1991, E. L. Stout: Polynomial convexity. Birkhäuser, 2007, F. Forstnerič: Stein manifolds and holomorphic mappings. The homotopy principle in complex analysis, Springer 2011. He developed the pseudoconvexity school in Romania and among his students were Nicolae Mihalache, Viorel Vâjăitu, Cezar Joiţa, Anca Popa, Natalia Gasiţoi, George Ioniţă.

**Among his most important results we mention:**

- In a paper that appeared in Nagoya J. Math. [24] he solved a problem that was posed by W. Barth (Invent. Math.1970) and was open for 27 years. Namely he proved that in  $\mathbb{P}^n$  the complement of a connected closed analytic set is cohomologically  $(n - 1)$ -complete. This problem is closely related to the following unsolved problem which in the 60's was already considered classic by A. Grothendieck: is it true that a connected closed curve in  $\mathbb{P}^3$  can be defined by two equations?
- He gave characterization of 1-convex spaces using strictly plurisubharmonic functions that are allowed to assume the value  $-\infty$  (in Math. Ann. 1985 [6]). In particular he solved a problem raised by Forneaess and Narasiman (Math. Ann. 1980), the most difficult part being actually the converse of their problem. This result, together with H. Grauert's characterization of the exceptional sets via the negativity of the normal bundle, is the finest criterion for studying the exceptional sets. It is also the key step in [42], paper in which is solved the Levi problem for Riemann domains over Stein spaces with isolated singularities, [19] and [49].
- The construction (in Math. Ann. 2009 [44]) of a new example of a 2-dimensional concave hole that cannot be filled. The previous example was constructed in the 60's by H. Grauert who used the theory of deformations of complex structures in his construction.
- The counterexample to the hyperintersection problem in Ann. Math. 1997 where it is constructed an example of an open subset  $D$  of a Stein space of dimension 3 having only one isolated normal singularity such that  $D$  is not Stein but its intersection with every hypersurface is Stein. This example suggests that the answers to the singular Levi problem (which is unsolved for more than a half of century) could be negative, however no example is known. The singular Levi problem can be stated as follows: is it true that a locally open Stein subset of a Stein space is Stein? The origins of this problem go back to 1910 but in this form, for Stein manifolds was stated for the first time by H. Cartan in 1953.
- The construction in Math. Ann. 1998 [27] of a counterexample to the Oka-Grauert principle for 1-convex spaces. In this paper it is constructed an example of a 1-convex complex space  $X$  and a holomorphic line bundle on  $X$  which is topologically trivial on  $X$ , is holomorphically trivial on a neighborhood of the exceptional set of  $X$ , however is not holomorphically trivial on the entire space  $X$ . This example answers a problem raised by G.Henkin and J.Leiterer who have tried to prove that such an example does not exist.
- The study of the homology Stein spaces and the relative homology of Runge pairs Runge in J. reine angew. Math. 1986 [8]. In this paper it is solved, for Stein spaces with arbitrary singularities, a problem posed by Andreotti and Narasimhan in Ann. Math. in the 60s. At that time they were able to prove it only for Stein spaces with isolated singularities. In the

same paper is solved a problem raised by R. Narasiman in *Invent. Math.* (independently H. Hamm proved it using Morse theory on manifolds with boundary).

- Results about the convexity type of complements of analytic subsets in Stein spaces [21] using topological methods (local Lefschetz type theorem of Hamm).

- In [37] is obtained one of the fundamental results in the classification of normal 2-dimensional singularities. It is shown that the universal covering space corresponding to the link is a Stein manifold if and only if the fundamental group of the link is Stein. This result is used in [44] to study the famous union problem for 2-dimensional Stein spaces.

- In [52] it is constructed a counterexample to the open immersion problem, i.e. an irreducible complex space  $Y$  such that the global holomorphic functions on  $Y$  separate points and give local coordinates, but  $Y$  cannot be realized as an open subset of a Stein space.

- In three papers ([49], [53], [55]) there have been obtained strong results concerning the coverings of 1-convex surfaces: it is possible that such covering  $X$  does not satisfy the disk property if it contains an infinite string of rational curves and for the structure sheaf  $\mathcal{O}_X$  of  $X$  it might happen that the first cohomology group  $H^1(X, \mathcal{O}_X)$  is not separated.

#### **Invited positions:**

- 1991: 2 weeks Univ. Wuppertal
- 1993: 6 weeks Univ. La Sapienza, Roma
- 1994: 1 month Univ. Wuppertal
- 1995: 2 months Univ. Wuppertal
- 1995: 1 month Univ. La Sapienza, Roma
- 1996: 1 month Univ. Potenza
- 1999: 6 weeks Univ. Wuppertal
- 2001: 2 weeks Humboldt University, Berlin
- 2001: 2 weeks Univ. Parma
- 2003: 8 weeks Univ. Wuppertal
- 2004: 1 month Univ. Lille 1
- 2004: 1 month Univ. La Sapienza, Roma
- 2004: 3 weeks Univ. Wuppertal
- 2005: 3 weeks Univ. Wuppertal
- 2005: 2 months Univ. Lille 1
- 2006: 3 months Univ. Lille 1
- 2006: 1 month Scuola Norm. Sup. Pisa
- 2007: 3 months Univ. Lille 1
- 2009: 1 month Univ. Lille 1

### Research fellowships:

- 1992-1993: Humboldt fellowship at Univ. Wuppertal
- 1994: 3 months DFG fellowship at Univ. Wuppertal and Humboldt University, Berlin
- 1995: 3 months DFG fellowship at Humboldt University, Berlin
- 1996: 3 months DFG fellowship at Humboldt University, Berlin
- 1998: 3 months DFG fellowship at Univ. Wuppertal
- 1999: 3 months DFG fellowship at Univ. Wuppertal
- 2000: 3 months DFG fellowship at Humboldt University, Berlin
- 2000: 3 weeks, Univ. Lille, CNRS - Romanian Academy echnages
- 2000-2001: 3 months chercheur haut niveau at Univ. Lille 1
- 2001: 3 months DFG fellowship at Humboldt University, Berlin
- 2002: 3 months DFG fellowship at Humboldt University, Berlin
- 2002: 5 months Humboldt fellowship at Univ Humboldt University, Berlin
- 2003: 2 months Humboldt fellowship at Humboldt University, Berlin
- 2005: 2 months, Stability Pact in Eastern Europe fellowship awarded by the Humboldt Foundation at Humboldt University, Berlin
- 2005: 4 months fellowship at Max Planck Inst. for Mathematics, Bonn
- 2007-2008: 3 months fellowship at Max Planck Inst. for Mathematics

**Other remarks:** M. Colţoiu is one of the founding members of L'Ecole Normale Supérieure de Bucarest. He is a referee for many international mathematical like: Math. Z, Bull. Soc. Math. France, Manuscripta math., C.R. Acad. Sci. France, Doc. Math., Arh. der Math., Ann. Sc. Norm. Sup. Pisa, Ark. Mat., Monatshefte für Math., J. reine angew. Math., Duke J. Math., Adv. in Math., etc...

### Publications:

1. M. Colţoiu: Cohomology with compact support for real-analytic spaces. *Bolletino UMI* **18-A** (1981), 291-297.
2. M. Colţoiu, N. Mihalache: A remark on the local Steiness problem. *Math. Ann.* **264** (1983), 333-334.
3. M. Colţoiu: The Levi problem for cohomology classes. *Ann. Inst. Fourier* **34** (1984), 141-154.
4. M. Colţoiu: A note on Levi's problem with discontinuous functions. *L'Ensgn. Math.* **31** (1985), 299-304.
5. M. Colţoiu: On the embedding of 1-convex manifolds with 1-dimensional exceptional set. *Comment. Math. Helv.* **60** (1985), 548-565.
6. M. Colţoiu, N. Mihalache: Strongly plurisubharmonic exhaustion functions on 1-convex spaces. *Math. Ann.* **270** (1985), 63-68.

7. M. Colţoiu: Convexity in complex analysis. *Stud. Cerc. Mat.* **38** (1986), 28-57.
8. M. Colţoiu, N. Mihalache: On the homology groups of Stein spaces and Runge pairs. *J. reine angew. Math.* **371** (1986), 216-220.
9. M. Colţoiu: Cohomology with compact support for Stein spaces. *J. reine angew. Math.* **380** (1987), 171-177.
10. M. Colţoiu: A remark on a theorem of Vo Van Tan. *Trans. AMS* **307** (1988), 857-859.
11. M. Colţoiu: Remarques sur les reunins croissantes d'ouverts de Stein. *C.R. Acad. Sci. Paris* **307** (1988), 91-94.
12. M. Colţoiu, N. Mihalache: Pseudoconvex domains on complex spaces with singularities. *Comp. Math.* **72** (1989), 241-247.
13. M. Colţoiu: Complete locally pluripolar sets. *J. reine angew. Math.* **412** (1990), 108-112.
14. M. Colţoiu: Recouvrements de Stein finis pour les espaces complexes. *C. R. Acad. Sci. Paris* **310** (1990), 397-399.
15. M. Colţoiu: Local hyperconvexity and local hyperconcavity. In: Aspects of Mathematics 1990. Complex analysis (vol. in honour of H. Grauert).
16. M. Colţoiu: Traces of Runge domains on analytic subsets. *Math. Ann.* **290** (1991), 545-548.
17. M. Colţoiu: Some open problems concerning Stein spaces. *Rev. Roumaine Math. Pures et Appl.* **36** (1991), 225-229.
18. M. Colţoiu: n-concavity of n-dimensional complex spaces. *Math. Z.* **210** (1992), 203-206.
19. M. Colţoiu: Coverings of 1-convex manifolds with 1-dimensional exceptional set. *Comment. Math. Helv.* **68** (1993), 469-479.
20. M. Colţoiu, A. Silva: Behnke-Stein theorem on complex spaces with singularities. *Nagoya J. Math.* **137** (1995), 153-160.
21. M. Colţoiu, K. Diederich: Convexity properties of analytic complements in Stein spaces. *J. of Fourier Anal. and Appl.*, Kahane special issue, **1** (1995), 183-194.
22. M. Colţoiu: A counterexample to the q-Levi problem in  $\mathbb{P}^n$ . *J. Math. Kyoto Univ.* **36** (1996), 385-387.
23. M. Colţoiu: Stein spaces. A survey. In: Seminari di geometria. Universita Bologna **9** (1996), 71-79.
24. M. Colţoiu: On Barth's conjecture concerning  $H^{n-1}(\mathbb{P}^n \setminus A, \mathcal{F})$ . *Nagoya Math. J.* **145** (1997), 99-123.

25. M. Colţoiu, K. Diederich: Open sets with Stein hypersurface sections in Stein spaces. *Ann. of Math.* **145** (1997), 175-182.
26. M. Colţoiu:  $q$ -convexity. A survey. In: Complex analysis and geometry XII, Pitman Research Notes in Math. vol. 366, 83-93.
27. M. Colţoiu: On the Oka-Grauert principle for 1-convex manifolds. *Math. Ann.* **310** (1998), 561-569.
28. M. Colţoiu, K. Diederich: Existence of 2-complete neighbourhoods for pseudoconvex domains. *J. of Geom. Anal.* **8** (1998), 21-25.
29. M. Colţoiu: On 1-convex manifolds with 1-dimensional exceptional set. *Rev. Roumaine Math. Pures et Appl.* **43** (1998), 97-104 (vol. dedicated to Prof. M. Jurchescu).
30. M. Colţoiu: On hulls of meromorphy and a class of Stein manifolds. *Ann. Sc. Norm. Sup. Pisa* **28** (1999), 405-412.
31. M. Colţoiu, K. Diederich: The Levi problem on Stein spaces and envelopes of holomorphy. *Math. Ann.* **316** (2000), 185-199.
32. M. Colţoiu, V. Vâjăitu: Locally trivial fibrations with 1-dimensional Stein fiber over  $q$ -complete spaces. *Nagoya J. Math.* **157** (2000), 1-13.
33. M. Colţoiu, K. Diederich: On the coverings of proper families of 1-dimensional complex spaces. *Mich. J. Math.* **47** (2000), 369-375.
34. M. Colţoiu: On the relative homology of  $q$ -Runge pairs. *Ark. for Math.* **38** (2000), 45-52.
35. M. Colţoiu, V. Vâjăitu: On the  $n$ -completeness of covering spaces with parameters. *Math. Z.* **237** (2001), 815-831.
36. M. Colţoiu, K. Diederich: A remark on non-Hausdorff cohomology groups of analytic complements. *Math. Ann.* **323** (2002), 486-489.
37. M. Colţoiu, M. Tibăr: Steiness of the universal covering of the complement of a 2-dimensional complex singularity. *Math. Ann.* **326** (2003), 95-104.
38. M. Colţoiu: Weakly pseudoconvex domains in 1-convex spaces and the hyperintersection problem. *Math. Z.* **245** (2003), 217-220.
39. M. Colţoiu: On  $q$ -Runge pairs. *Ann. Sc. Norm. Sup. Pisa (5)* **2** (2003), 231-235.
40. M. Colţoiu: On the separation of the cohomology groups of increasing unions of  $(1, 1)$  convex-concave manifolds. *J. Math. Kyoto Univ.* **45** (2005), 405-409.
41. M. Colţoiu: Some remarks about 1-convex manifolds on which all holomorphic line bundles are trivial, *Bull. Sci. Math.* **130** (2006), 337-340.
42. M. Colţoiu, K. Diederich: The Levi problem for Riemann domains over Stein spaces with isolated singularities, *Math. Ann.* **338** (2007), 283-289.

43. M. Colţoiu: Convexity properties of coverings of 1-convex manifolds, *Math. Z.* **256** (2007), 461-464.
44. M. Colţoiu, M. Tibăr: On the disk theorem, *Math. Ann.* **345** (2009), 175-183.
45. M. Colţoiu: The Levi problem on Stein spaces with singularities. A survey. *Rendiconti Mat. (Roma)* **29** (2009), 341-353.
46. M. Colţoiu, J. Ruppenthal: A d-bar theoretical proof of Hartogs' extension theorem on  $(n - 1)$ -complete complex spaces. *J. reine angew. Math.* **637** (2009), 41-47.
47. M. Colţoiu, C. Joiţa: The Levi problem in the blow-up. *Osaka J. Math.* **47** (2010), no. 4, 943-947.
48. G. Chiriacescu, M. Colţoiu, C. Joiţa: Analytic cohomology groups in top degrees of Zariski open sets in  $\mathbb{P}^n$ , *Math. Z.* **264** (2010), 671-677.
49. M. Colţoiu, C. Joiţa: The disk property of coverings of 1-convex surfaces, *Proceedings of the AMS* **140** (2012), no. 2, 575-580.
50. M. Colţoiu, N. Gaşitoi, C. Joiţa: On the image of an algebraic projective space. *C. R. Math. Acad. Sci. Paris* **350** (2012), no. 5-6, 239-241.
51. M. Colţoiu, C. Joiţa, M. Tibăr:  $q$ -convexity properties of the coverings of a link singularity. *Publ. Res. Inst. Math. Sci.* **48** (2012), no. 2, 409-417.
52. M. Colţoiu, C. Joiţa: On the open immersion problem. *Math. Ann.* **356** (2013), no. 3, 1203-1211.
53. M. Colţoiu, C. Joiţa: Convexity properties of coverings of 1-convex surfaces. *Math. Z.* **275** (2013), no. 3-4, 781-792.
54. M. Colţoiu, K. Diederich, C. Joiţa: On complex spaces with prescribed singularities. *Math. Res. Lett.* **20** (2013), no. 5, 857-868.
55. M. Colţoiu, C. Joiţa: On the separation of the cohomology of universal coverings of 1-convex surfaces. *Adv. Math.* **265** (2014), 362-370.
56. M. Colţoiu, C. Joiţa: On the parameterization of germs of two-dimensional singularities. *J. Geom. Anal.* **25** (2015), no. 4, 2427-2435.
57. M. Colţoiu, C. Joiţa: On Runge-curved domains in Stein spaces. To appear in *Annali della Scuola Normale Superiore di Pisa*.