

Professional record for

Syvert P. Nørsett

Graduated from the University of Oslo, Norway, 1969, master thesis on “The numerical solution of stiff systems”

01.01.70 to 01.08.70 worked at the Byggedata company on problems related to automatic map generation.

01.09.72 to 01.06.74 Ph.D. student at the University of Dundee, Scotland, supervised by Prof. Jack Lambert.

Granted the PhD in the middle of 1975, PhD thesis on “Numerical solution of ordinary differential equations”.

01.08.70 – 01.08.86 employed as Associated Professor at NTH, the technical university of Norway, in numerical mathematics.

01.08.86 – employed as Full Professor at NTH, the technical university of Norway, in numerical mathematics.

Leaves of absence:

Spring 1978 at the university of Geneva, Switzerland employed as Charge de Recherche.

Fall 1982 to Spring 1983 at the University of Waterloo and the University of Toronto.

Fall 1990 to Spring 1991 at NTH to write the book on *Order Stars*.

Fall 96 to spring 97 at DAMTP, University of Cambridge England

Fall 03 to spring 04 at DAMTP, University of Cambridge England

Spring 07 at DAMTP, University of Cambridge England

Professional distinctions:

Member of The Royal Norwegian Society for Science and Letters.

Member of The Norwegian Academy of Technological Sciences.

Excellent evaluation in “Informatics : Research and Teaching in Norway, A Critical Evaluation” by NAVF: The Council for Natural Science Research.

Editorial responsibilities:

BIT,

Mathematics of Computation

Research activities

My research can be divided into two parts, numerical solution of ordinary differential equations and approximation theory.

Numerical solution of ordinary differential equations

In my master thesis in 1969 I became for first time involved in stiff systems. At that time Dahlquist had introduced the notion of stiffness and A-stability. I started with two papers, one on A-stability and one on an A-stable modification of Adams–Bashforth methods. After these first papers on stiff systems, I have worked and produced a number of papers, as well as supervising students in that area. During my work on the Ph.D. dissertation I become very interested in the theory behind the Runge–Kutta methods, mainly due to John Butcher. My Ph.D. work had one chapter on using his theory for the SDIRK methods. In my year in Canada I worked together with Prof. Per Thomsen on a program, SIMPLE, based on this class of methods.

*Last year I started together with Prof. Gustaf Söderlind from the University of Lund, Sweden and Prof. Per Thomsen from DTH, Denmark a project to write a new version of that program, SIMPLE2000. It is part of the **GODESS** project and this work is sponsored by the Nordic Council, NORFA.*

During my stay in Geneva I worked together with Prof. Gerhard Wanner and Prof. Ernst Hairer. Our concern at that time was the conjecture of Ehle on the A-stability of methods with rational function as approximations to the exponential function. The classical approach of using the maximal modulus theorem could not give the answer. It turned out that a new tool was required and this has led to the theory of Order Stars. Not only did it solve this famous conjecture, but it led to a series of applications to other fields in mathematics. During this work I was fortunate to collaborate with Dr Arie Iserles, University of Cambridge, England. This theory has now been collected in our book, Order Stars, Theory and applications (Chapman & Hall, 1991). During my stay in Geneva I also started, together with Hairer and Wanner, to write a book on numerical methods for ordinary differential equations, published by Springer-Verlag (1987). The second edition of that book has appeared in 1991.

In later years I have been involved in work on parallel ODE solvers. This is work done together with Prof. Ken Jackson, Toronto and Dr Iserles, Cambridge as well as Dr Anne Kværnø.

Approximation theory

The discussion of stability for numerical methods for ODE is connected to approximations to the exponential function. Different papers on approximants to $\exp(z)$ have been written. The first papers came out from my Ph.D. thesis. There I started the work on C-polynomials which is closely connected to the collocation idea. The idea of collocation has been extended during my stay in Geneva to cover the entire class of Runge–Kutta methods, in the form of perturbed collocation. Motivated by efficiency considerations, I also proposed to replace classical Padé approximants to $\exp(z)$ by restricted approximants. This type of approximants is related to the stability-function of SDIRK-methods and SIRK methods.

In 1982 I met Iserles at a conference in Tampa, Florida USA. There we started the work on biorthogonal polynomials. It opened a whole new discipline for us and for many mathematicians as well. As a matter of fact, we intend to write this work in a new book, but the work is still in progress.

In later years I started a work on Sobolev orthogonal polynomials. The work was done together with A. Iserles, J.M. Sanz-Serna, Spain and P.E. Koch, NTH. This work is still in progress.

The last project I have been involved in together with Prof. Ken Jackson, Toronto and Dr Iserles, Cambridge as well as Dr Anne Kværnø, on the order behaviour when Newton-type iteration is used for the nonlinear systems when Runge–Kutta methods are used as the time integrator.

PhD. students supervised during 1970–1995.

Ivar AAvatsmark(1980) "Analytiske og Numeriske Egenskaper til Singulært Forstyrrede Topunkts Randverdiproblemer med et Indre Grensesjiktgivende Annenordens Vendepunkt"(In Norwegian).

Ivar Lie (1985) "Multistep Collocation for Siff Systems"

Jostein Alvestad (1987) "Front Tracking Methods Including Diffusion For Hydrocarbon Reservoir Simulation"

Anne Kværnø (1988) "Runge-Kutta Methods for the Numerical Solution of Differential-Algebraic Equations of Index 1"

Arne Slåttsveen (1989) "Simulering an en Al-celle med ALCEL 3" (in Norwegian)

Brynjulf Owren (1989) "Continuous explicit Runge–Kutta methods with applications to ordinary and delay differential equations"

Hans Munthe-Kaas (1989) "Topics in linear algebra for vector and parallel computers"

Harald Holm Simonsen (1990) "Extrapolation methods for ODE's: continuous approximations, a parallel approach"

Jørn Amundsen (1993) "Distributed and parallel Hamiltonian molecular dynamics"

Morten Bjørhus (1995) "On domain decomposition, subdomain iteration, and waveform relaxation"

Roar Skålin (1997) "Selected parallel algoritms for numerical weather prediction"

Inge Morten Skaar(2001) "Monitoring the Lining of a Melting Furnace"

Andreas Asheim(2010) "Numerical Methods for Highly oscillatory Problems"

Supervised PhD students from other faculties and Universities:

Other faculties at University of Trondheim:

Torleif Iversen (1990) "Modular techniques in dynamic process simulation"

Tor Helge Hansen (1991) "Parallel techniques for solving finite element problems on transputer networks"

Bente Østigård (1995) "Dualorthogonal Polynomials"

Christophe Rene Birkeland (1997) "Quantitative methods in electron diffraction and microscopy" with Proffessor Ragnvalh Høier.

Sverre Gvevskott (1997) "Studies on modelling of bubble driven flows in chemical reactors" with Professor Hallvard F. Svendsen.

*Jens Hoilmen (2002) "Turbulence Modelling for Stratified Flow"
Sammem med Professor Geir Moe*

At University of Ljubljania, Slovenia:

Bojan Orel (1991) "Runge-Kutta methods with real eigenvalues"

ESSO prizes to PDH thesises

The university NTNU hans out two prizes evry year to the two best phd thesis.

The numerical group has obtained the ESSO prize tree times. The students are:

ALVESTAD

MUNTHE-KAAS

BJØRHUS

Master students

1984: 1
1985: 1
1986: 4
1987: 0
1988: 1
1989: 5
1990: 2
1991: 0
1992: 2
1993: 1
1994: 3
1995: 2
1996: 5
1997: 1
1998: 2
1999: 1
2000: 4
2002: 1
2003: 3
2004: 1
2006: 1

Books

1. *Solving ordinary differential equations I*. Springer-Verlag 1987. Written together with E. Hairer, Univ. de Geneve, G. Wanner, Univ. de Geneve. Revised version in 1994.
2. *Order stars*. Chapman and Hall, 1991. Written together with A. Iserles, Univ. of Cambridge.
3. Guest Editor with A. Iserles of
Themes in Geometric Integration
a special Issue of
Applied Numerical Mathematics, 2001 Volume 39 Numbers 3-4

Papers

1. *A-stable modification of the Adams-Bashforth methods*. Springer Lecture notes in Mathematics, no 109 1969. pp 214-219

2. *A criterion for $A(\alpha)$ – stability of linear multistep methods.* BIT **9**, 1969, 259–263.
3. *One-step methods of Hermite type for numerical integration of stiff systems.* BIT **14** (1974) 63–77.
4. *C-polynomials for rational approximation to the exponential function.* Numer. Math. **25** (1975) 39–56.
5. *A note on local Galerkin and collocation methods for ordinary differential equations.* Utilitas Math. **7** (1975) 197–209.
6. *Runge–Kutta methods with a multiple real eigenvalue only.* BIT **16** (1976) 388–393.
7. *Attainable order of rational approximations to the exponential function with real poles.* BIT **17** (1977) 200–208. (Joint work with Arne Wolbrandt).
8. *Restricted Padé approximations to the exponential function.* SIAM J. Anal. **15** (1978) 1008–1029.
9. *Order stars and stability theorems.* BIT **18** (1978) 475–489. (Joint work with Ernst Hairer and Gerhard Wanner).
10. *The real-pole sandwich for rational approximations and oscillation equations.* BIT **19** (1979) 79–84. (Joint work with Gerhard Wanner.)
11. *Order conditions for Rosenbrock type methods.* Numer. Math. **32** (1979) 1–15. (Joint work with Arne Wolbrandt.)
12. *Perturbed collocation and Runge–Kutta methods.* Numer. Math. **36** (1981) 193–208. (Joint work with Gerhard Wanner.)
13. *Superconvergence of collocation methods for Volterra and Abel equations of the second kind.* Numer Math. **36** (1981) 347–358.
14. *Order of convergence of one-step methods for Volterra integral equations of the second kind.* SIAM J. Numer. Anal. **29** (1983) 569–579. (Joint work with Ernst Hairer and Christian Lubich.)
15. *Embedded SDIRK-methods of basic order three.* BIT **24** (1984) 634–646. (Joint work with P.G. Thomsen.)
16. *Frequency fitting of rational approximations to the exponential function,* Math. Comput. **40** (1983) 547–559. (Joint work with Arieh Iserles.)
17. *A-acceptability of derivatives of rational approximations to $\exp(z)$.* J. Approx. Th. **43** (1985) 327–337. (Joint work with Arieh Iserles.)

18. *The numerical solution of differential and differential/algebraic systems*, Modelling, Identification and Control **6** (1985) 141–152.
19. *Rational approximations to the exponential function with two complex conjugate interpolation points*. SIAM J. Math. Anal. **16** (1985) 814–821. (Joint work with Ernst Hairer and Arieh Iserles.)
20. *Displacement or residual test in the application of implicit methods for stiff problems*, IMA J. of Numer. Anal. **5** (1985) 297–305. (Joint work with N. Houbak and P.G. Thomsen.)
21. *Order-constrained uniform approximations to the exponential based on restricted rationals*, Constr. Appr. **2** (1986) 189–195. (Joint work with S.R. Trickett.)
22. *Switching between modified Newton and fix-point iteration for implicit ODE-solvers*. BIT **26** (1986) 339–348. (Joint work with P.G. Thomsen.)
23. *Error control of rational approximations to the exponential function*, Constr. Appr. **2** (1986) 41–57. (Joint work with Arieh Iserles.)
24. *Interpolants for Runge–Kutta formulas*. ACM Trans. on Math. Software **12** (1986) 193–218. (Joint work with W.H. Enright, K.R. Jackson and P.G. Thomsen.)
25. *Local error control in SDIRK*, BIT **26** (1986) 110–113. (Joint work with P.G. Thomsen.)
26. *Two-step methods and bi-orthogonality*, Math. Comp. **49** (1987) 543–552. (Joint work with Arieh Iserles.)
27. *Bi-orthogonality and zeroes of transformed polynomials*, J. of Comp. and Appl. Math. **19** (1987) 39–45. (Joint work with Arieh Iserles.)
28. *Aspects of Parallel Runge-Kutta Methods*, in "Numerical Methods for Ordinary Differential Equations" Proceedings, LAquila 1987, Springer Lecture Notes in Math. 1386, pp.103-118.
29. *On the theory of bi-orthogonal polynomials*, Trans. Amer. Math. Soc. **306** (1988) 455–474. (Joint work with Arieh Iserles.)
30. *Effective solution of discontinuous IVP's using a Runge–Kutta formula pair with interpolants*. Appl. Math. Comp. **27** (1988) 313–335. (Joint work with W.H. Enright, K.R. Jackson and P.G. Thomsen.)
31. *Order stars and rational approximants to $\exp(z)$* , Appl. Num. Math. **5** (1989) 63–70. (Joint work with Arieh Iserles.)

32. *Christoffel-Darboux-type formulas and a recurrence for biorthogonal polynomials*, *Const. Appr.* **5** (1989) 437–453. (Joint work with Arieh Iserles.)
33. *Superconvergence for multistep collocation*, *Math. of Comp.* **52** (1989), 65–79. (Joint work with Ivar Lie.)
34. *Zeros of transformed polynomials*, *SIAM J. Math. Anal.* **21** (1990), 483–509. (Joint work with Arieh Iserles.)
35. *On the theory of parallel Runge-Kutta methods*, *IMA J. of Numer. Anal.* **19** (1990) 463–488. (Joint work with A. Iserles.)
36. *On transformations and zeroes of polynomials*, *Rocky Mntn. Math.* **21** (1991) 331–357. (Joint work with A. Iserles and E.B. Saff.)
37. *On polynomials orthogonal with respect to certain Sobolev inner products*, *J. Approximation Theory* **65** (1991) 151–175. (Joint work with A. Iserles, P.E. Koch, and J.M. Sanz-Serna.)
38. *Biorthogonal polynomials in numerical ODEs*, *Annals of Numerical Mathematics* **.1**(1994), 153-170.
39. *The use of Butcher series in the analysis of Newton-like iterations in Runge-Kutta formulas*, *Annals of Numerical Mathematics* **.1**(1994), 341–356. (joint with K.R.Jackson and Anne Kværnø)
40. *The potential for parallelism in Runge-Kutta methods. Part 1: RK Formulas in standard form*, *SIAM J. Numer. Anal.* **32** (1995) 49–82. (Joint work with Ken Jackson.)
41. *Explicit representations of biorthogonal polynomials*, *Num. Algorithms* **10** (1995), 51–68. (Joint work with Arieh Iserles.)
42. *Characterization of all zero-mapping transformations of a given form, to appear in Comp. & Maths Appls.* (Joint work with Arieh Iserles.)
43. *Biorthogonal polynomials in numerical ODEs. Annals of Numerical (Joint work with Arieh Iserles.) Mathematics 1(1994) 153-170.*
44. *Dual-orthogonal polynomials*, *Numerical Algorithms* **11**(1996) 311-326.
45. *Preconditioning waveform relaxation iterations for differential systems*, *BIT* (1996) 54-76 (Joint wit K.Burrage, Z. Jackiewicz, R.A.Renaut)
46. *An Analysis of the order of Runge-Kutta methods that use an iterative scheme to compute their internal stage values*, *BIT* (1996) 713-765. (Joint with Jackson and Kværnø)

47. *Runge=Kutta research in Trondheim, Applied Numerical Mathematics 22(1996) 263-277. (Joint with A. Kværnø and B. Owren)*
48. *On the solution of linear differential equations in Lie groups, Phil. Trans. Royal Soc. A 357(1999) 983-1020. (Joint with A.Iserles)*
49. *On the implementation of the method of Magnus series for linear differential equations, BIT (1999) 281-304.
(Joint with A.Iserles and A. Marthinsen)*
50. *Computational Methods for Fluid-Structure Interaction, Tapir 1999. Medredaktør sammen med T. Kvamsdal. Ib Enevoldsen, Kjell Herfjord, Carl B. Jenssen*
51. *Lie-group methods Acta Numerica, Cambridge University Press (2000)215-365 (Joint with A.Iserles,H. Z. Munthe-Kaas,A.Zanna)*
52. *Themes in Geometric Integration, Guest editor Syvert P. Norset og A. Iserles for Imacs Journal ISSN 0168-9274 121 pp*
53. *Time symmetry and high-order Magnus methods,In Special Issue: Themes in Geometric Integration of Numerical Mathematics Des 2001 pp 379-403
(Joint with A.Iserles and A.F.Rasmussen)*
54. *Efficient quadrature of highly oscillatory integrals using derivatives , Proceedings of the Royal Society, Series A(2005)pp. 1383 - 1399*
55. *On quadrature methods for highly oscillatory integrals and their implementation, BIT 44 2004 pp. 755-772*
56. *On the computation of highly oscillatory multivariate integrals with stationary points, BIT 46 2006 pp.549-566*
57. *Quadrature methods for multivariate highly oscillatory integrals using derivatives, Math Comp 75 2006 pp. 1233-1258*
58. *A. Iserles, S.P. Nørsett and S. Olver "Highly oscillatory quadrature: The story so far", Proceedings of ENuMath, Santiago de Compostela (2006) (A. Bermudez de Castro et al., eds), Springer-Verlag, Berlin (2006), 97-118.*
59. *From high oscillation to rapid approximation I: modified Fourier expansions IMA Journal of Numerical Analysis published April 2 2008, 26 pages(joint with Arieh Iserles)*
60. *From high oscillations to rapid approximation III: multivariate expansions IMA Journal of Numerical Analysis published July 25 2008, 35 pages(joint with Arieh Iserles)*

61. *The spectral problem for a class of highly oscillatory Fredholm integral operators IMA Journal of Numerical Analysis published July 25 2008, July 30 2008, ,20 pages(joint with Herman Brunner and Arieh Iserles)*
62. *From high oscillation to rapid approximation IV: Accelerating convergence. IMA Journal of Numerical Analysis published pp 26, 2010(joint with Daan Huybrechs and Arieh Iserles)*
63. *The computation of the spectra of highly oscillatory Fredholm integral operators J. Integral Eqns and Operator Theory(joint with Brunner and Iserles)*
64. *On the singular values of the Fox-Li operator(joint with Brunner and Iserles)*
65. *From high oscillation II : expansions in Birkhoff series (joint with Adcock and Iserles) IMA Journal of Numerical Analysis May 26, 2011, pp1..36*

Proceedings

1. *An A-stable modification of the Adams-Bashforth method. In Conf. on the Numerical Solution of Differential Equations, Dundee, 1969 (1969a.) Ed. J.L. Morris) Lecture Series in Mathematics No. 109 , Springer, Berlin, 214–219.*
2. *Collocation and perturbed collocation methods. In Numerical Analysis: Proc. Dundee, 1979 (Ed. G.A. Watson), Lecture Notes in Mathematics No. 773, Springer, Berlin. 119–132.*
3. *Splines and collocation for ordinary initial value problems, in Approximation Theory and Spline Functions (S.P. Singh, J.W.H. Burry and B. Watson eds), D. Reidel Publishing Company (1984) 397–418.*
4. *Bi-orthogonal polynomials. In Orthogonal Polynomials, Bar-le-Duc 1984 (C. Brezinski et al., eds), Springer Verlag LNiM 1171 (1985) 92–100. (Joint work with Arieh Iserles.)*
5. *Exponential fitting of restricted rational approximation to the exponential function, in Rational Approximation and Interpolation (P.R. Graves-Morris, E.B. Saff and R.S. Varga eds), Springer-Verlag LNiM 1105, Berlin (1986) 466–476.*
6. *Aspects of parallel Runge–Kutta methods, in Numerical methods for Ordinary Differential Equations Lecture Notes in Math. no. 1386. Proceedings of the l’Aquila Symposium 1987 (A. Bellen, C.W. Gear and E. Russo eds), Springer-Verlag 1989, 103–107. (Joint work with H.H. Simonsen.)*

7. *Error control of rational approximations with matrix argument.* In *Approximation of Functions and Data* (M.G. Cox and J.C. Mason, eds) Oxford Univ. Press (1987) 293–305. (Joint work with Arieh Iserles.)
8. *Parallel Runge–Kutta methods.* In *Numerical Ordinary Differential Equations*, London 1989 (J. Cash and I. Gladwell, eds), Oxford Univ. Press (1992) 385–392. (Joint work with Arieh Iserles.)
9. *Orthogonality and approximation in a Sobolev space,* in *Algorithms for Approximations* (J.C. Mason, M.G. Cox eds), Chapman and Hall, London 1990. (Joint work with A. Iserles, P.E. Koch, NTH, J.M. Sanz-Serna.)
10. *Runge–Kutta methods for neutral differential equations.* In *Contributions in Numerical Mathematics* (R.P. Agarwal, ed.), *World Scientific Series in Applicable Analysis*, World Scientific, Singapore (1993) 85–98. (Joint work with M.D. Buhmann and A. Iserles.)