Curriculum Vitae and Publication List

Craig D. Roberts

April, 2005

Contents

1 Curriculum Vitae

NAME : Craig Darrian ROBERTS

BIRTHDATE : 29th October 1962

NATIONALITY : Citizen of the USA and Australian Citizen

ADDRESS : Physics Division
Argonne National Laboratory
Argonne, IL 60439-4843, USA
EMail: cdroberts@anl.gov
Tel: + 1 630 252 4095
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www: http://www.phy.anl.gov/theory/staff/cdr.html

DEGREES OBTAINED :

1988 - PhD, Theoretical Particle Physics,
Flinders University of South Australia
1984 - BSc (Hons), Theoretical Particle Physics,
Flinders University of South Australia.
∗ Awarded University Medal.
1983 - BSc, Theoretical Physics,
Flinders University of South Australia.
∗ Awarded Chancellor's Letter of Commendation.

EMPLOYMENT HISTORY :

2001 - Present: Theory Group Leader
Argonne National Laboratory

2004 - Present: Physicist (Grade 708)
Argonne National Laboratory
2002 - 2004: Physicist (Grade 707)
Argonne National Laboratory
1996 - 2001: Physicist (Grade 706)
Argonne National Laboratory
1991 - 1996: Assistant Physicist (Grade 705, Tenure Track)
Argonne National Laboratory

1989 - 1991: Postdoctoral Fellow, Argonne National Laboratory
1987 - 1989: Postdoctoral Fellow, University of Melbourne, Victoria

1997 - Present: Adjunct Research Professor, Kent State University
1991 - 1995: Adjunct Research Scientist, Kent State University

AWARDS :

2003: Recipient, Friedrich Wilhelm Bessel Research Award
of the Alexander von Humboldt Foundation
http://www.avh.de/en/programme/preise/bessel.htm

2001: Elected Fellow of the American Physical Society

2001-2002: DFG Mercator Visiting Professor, University of Rostock

1996: Distinguished Visiting Scholar, Faculty of Science, University of Adelaide

PROFESSIONAL ACTIVITIES :

Field Editor, "Elementary Particles and Fields,"
Few Body Systems, published by Springer-Verlag.

Executive Committee
2005: "Vice-Chair" American Physical Society Topical Group on Hadronic Physics
2004: "Member at Large": American Physical Society Topical Group on Hadronic Physics
2003: "Member at Large": American Physical Society Topical Group on Hadronic Physics

Member:

- American Physical Society
  Topical Group on Few Body Systems and Multiparticle Dynamics;
- American Physical Society
  Topical Group on Hadronic Physics
- Australian Institute of Physics

Panel Member:
2004 Science and Technology Review,
Thomas Jefferson National Accelerator Facility (JLab)

Referee for:
European Physical Journal A; Few Body Systems; Fizika B; International Journal of Modern Physics A; Journal of Physics A; Journal of Physics G; Journal of High Energy Physics; Modern Physics Letters; New Journal of Physics; Nuclear Physics A; Nuclear Physics B; Physical Review Letters; Physics Letters B; Physical Review C; Physical Review D; Progress in Particle and Nuclear Physics

Reviewer of Proposals for:
Argonne Theory Institute; Australian Research Council; INFN, Italy; International Science Foundation; US Civilian Research & Development Foundation (CRDF); US Department of Energy; US National Science Foundation

GRANTS HELD :

In addition to Argonne National Laboratory's Department of Energy, Office of Nuclear Physics, funding ...

1. Apr.'02 – Mar.'04: "US-German Cooperative Research: Quark Confinement and Hadronic Processes," $19 600, National Science Foundation, International Programs, INT-0129236, with P.C. Tandy, Kent State University
2. Oct.'01 – Sept.'02: Deutsche Forschungsgemeinschaft Grant No. Ro 1146/3-1, €24 208
3. Apr.'97 – Mar.'99: "US-German Cooperative Research: Hadron Observables at Finite Temperature and Baryon Density," $23 800, National Science Foundation, International Programs, INT-96-03385, with P.C. Tandy, Kent State University
4. Oct.'95 – Oct.'96: "Nucleon Amplitudes in QCD," $59 000, Individual Investigator Laboratory Director's Research and Development Grant
5. Mar.'93 – Jul.'95: "US-Australia Cooperative Research: Studies in Non-Perturbative QCD and Hadron Dynamics," $24 084, National Science Foundation, International Programs, INT-92-15223, with P.C. Tandy, Kent State University

POSTDOCTORAL SUPERVISION :

1. Stewart V. WRIGHT, 2004-Present ... Argonne National Laboratory
2. Arne HÖLL, 2003-Present ... Argonne National Laboratory
3. Andreas KRASSNIGG, 2003-2005 ... Argonne National Laboratory
   Erwin Schrödinger Fellow, Funded by Austrian Ministry of Education,
   Winner of 2002 Austrian Prize for Academic Excellence
   Currently
   ... Research Fellow, Institut für Physik, Universität Graz, Austria
4. Martin HECHT, 2000-2001
   Currently
   ... Student of Law, University of Melbourne
5. Sebastian SCHMIDT, 1999-2000
   Fiodor Lynen Fellow, Funded by Alexander von Humboldt Foundation
   Currently
   ... Programme Monitor, Energy Research and Structure of Matter,
   Helmholtz Gemeinschaft, Germany
   (The Helmholtz Gemeinschaft is Germany's equivalent of the Department of Energy.)
6. Jacques BLOCH, 1998-1999
   Currently
   ... Postdoctoral Fellow, Michigan State University
7. Pieter MARIS, 1996-1998
   Currently
   ... Department of Physics and Astronomy, University of Pittsburgh, USA
8. Lorenz von SMEKAL, 1996-1997
   Currently
   ... Lecturer, University of Adelaide, Australia
9. Axel BENDER, 1995-1996
   Currently
   ... Officer for Concept Studies and Analysis, Land Operations Division,
   Defence Science and Technology Organisation, Australia

2 Survey of Current Status

2.1 Conspectus of selected research contributions

My exploration of Quantum Electrodynamics using the Dyson-Schwinger equations (DSEs) culminated in an elucidation of the nonperturbative connection between multiplicative renormalisability and gauge covariance. Ensuring gauge covariance of DSE solutions, and hence gauge invariance of physical observables, had been a long-standing goal. The ultimate article in this series (see Pub. [2] on page 7 herein) provides a keystone for subsequent research in this area. (NB. I have written five major reviews on DSEs and their applications: Pub. [24], page 14; Pub. [48], page 16; Pub. [48], page 16; Pub. [60], page 17; and Pub. [69], page 17.)

This research led to the development of well-constrained nonperturbative *Ansätze* for the dressed-fermion–gauge-boson coupling, which is an essential element in the calculation of all electromagnetic cross sections involving hadrons. I established (Pub. [3], page 7) that these *Ansätze* guarantee the particular connection between hadronic electromagnetic form factors and the canonical normalisation of Bethe-Salpeter amplitudes which ensures electromagnetic current conservation. This cleared a way for the use of DSE techniques, and results, in calculating experimental observables; e.g., those measured at the Thomas Jefferson National Accelerator Laboratory (JLab). The procedure I introduced is currently in general use.

I also established (Pub. [3], page 7) the connection between a correct treatment of the dressed-quark–photon coupling and the automatic satisfaction of anomalous axial-vector Ward-Takahashi identities in the nonperturbative evaluation of hadronic decays and transition amplitudes. Before this work, those identities were enforced by hand as additional constraints on model building. This research made plain that Abelian anomalies are a global consequence of dynamical chiral symmetry breaking and also the mechanism by which this is ensured.

Interest in the realisation of quark confinement led me to explore features of the dressed-quark propagator by modelling the kernel of QCD's gap equation. I found that when the kernel exhibits sufficient support on the infrared domain $k^2 \in [0, 2]\,\mathrm{GeV}^2$ then chiral symmetry is dynamically broken and the analytic properties of the propagator are much modified; e.g., the propagator no longer has a Källén-Lehmann representation. The absence of such a representation is a sufficient condition for confinement and this observation led me to propose a confinement test (hep-ph/9309263), which has been used to good effect by other authors. I interpreted the momentum dependent modification of the dressed-quark propagator obtained in these model studies as a real feature of QCD, and used it as a basis for an efficacious dressed-quark-based, confining and Poincaré covariant model of electron-hadron and hadron-hadron interactions. That model has been taken up by other researchers and is a primary element of major review articles (For example: P.C. Tandy, Prog. Part. Nucl. Phys. **39** (1997) pp. 117-199; R. Alkofer and L. v. Smekal, Phys. Rept. **353** (2001) pp. 281-465). It continues to provide a standard against which more sophisticated, contemporary calculations are measured.

A given DSE couples an n-point vertex (Schwinger function) to other n- and $n+1$-point functions, and therefore their practical application requires a truncation in order to define a tractable problem. My experiences in developing the phenomenological model emphasised that a truncation's utility is much magnified if it preserves a theory's Ward-Takahashi identities. I succeeded in developing one systematic, nonperturbative, Ward-Takahashi identity preserving truncation scheme (Ref [4], page 7). In doing so I demonstrated why the often used

"rainbow-ladder" truncation, which is an analogue of the Hartree-Fock-ladder treatment, is reliable when studying dynamical chiral symmetry breaking and pseudoscalar mesons, and also explained why it fails for scalar mesons. The same procedure enabled me to prove that colour-antitriplet quark-quark (diquark) correlations, which exist as bound states when the rainbow-ladder truncation is used, are unbound when the full quark-quark scattering kernel is employed. Currently this is the only systematic, symmetry preserving truncation of the DSEs. It underlies the success of all direct and quantitatively accurate applications of DSE models of the quark-quark interaction to the calculation of hadron observables, the foundation for which I laid (Pub. [7], page 7). (NB. A minor variant of the model I introduced *predicted* the behaviour of the electromagnetic pion form factor, $F_\pi(Q^2)$, that was recently measured at JLab; i.e., the calculation appeared *before* the data were taken. All other pre-existing calculations are uniformly 2-4 standard deviations below that $Q^2F_\pi(Q^2)$ data.)

The existence of an axial-vector Ward-Takahashi identity preserving truncation allowed me to prove that the pion is both QCD's Goldstone boson and a massless bound-state of a dressed-quark and a dressed-antiquark (Pub. [6], page 7); i.e., to resolve the dichotomy of the pion. With this proof I also provided: the gauge- and renormalisation-point-independent expression for meson electroweak decay constants; a gauge- and cutoff-independent expression for the vacuum quark condensate; and a mass formula for flavour non-singlet pseudoscalar mesons. I also identified essential corollaries: a quark-level Goldberger-Treiman relation; the fact that pseudoscalar meson Bethe-Salpeter amplitudes necessarily have pseudovector components; and that the leptonic decay constant for every pseudoscalar meson, *except* the ground state pion, vanishes in the chiral limit. These are some of the few exact results proved in QCD. Having provided an understanding of the pion, I calculated its valence quark distribution function, $u_V^\pi(x)$ (Pub. [10], page 8). This calculation, which confirmed the perturbative QCD prediction and identified the mass-scale at which it must become evident, has refocused the community's attention on an extant discrepancy between theory and experiment, and is the catalyst for a resurgence of interest in $u_V^\pi(x)$ and proposals for its remeasurement (see Pub. [8], page 19).

I have also extended DSE theory and phenomenology to systems containing heavy-quarks (Pub. [8], page 7), recovering established heavy-quark limits and correlating an extensive range of light- and heavy-meson observables. In addition, my observation that the pseudoscalar meson mass formula is valid for any value of the current-quark masses allowed me to prove that the mass of a meson containing a heavy-quark grows linearly with the current-quark mass of its heaviest constituent. This furnishes a QCD proof of the result obtained in potential models.

I have also exploited the confinement test described above in the first simultaneous, continuum study of chiral symmetry restoration and deconfinement at nonzero temperature (Pub. [5], page 7), showing the transitions to be coincident. I then pioneered the practical application of the formalism to nonzero chemical potential and the exploration of bound state response to these intensive thermodynamic variables. These studies of hot, dense QCD in equilibrium are complemented and extended via my applications of quantum kinetic theory to the non-equilibrium process of evolution from an ultrarelativistic heavy ion collision to a quark-gluon plasma. Incipient in that is a connection between the appearance of a dressed-quark mass function and chiral symmetry restoration and re-confinement.

In summary, I have made a prominent contribution to the exploration, exposition and popularisation of DSEs as both a theoretical and practical phenomenological tool in QCD, and had a significant impact on contemporary hadron physics, in many of its domains.

2.2 Ten career-best publications

The ten publications I judge to be my most signficant.

1. ROBERTS, C.D. and WILLIAMS, A.G.
   Dyson-Schwinger Equations and their Application to Hadronic Physics
   hep-ph/9403224; Prog. Part. Nucl. Phys. **33** (1994) pp. 477-575.
   Citations: 318

2. DONG, Z., Munczek, H.J. and ROBERTS, C.D.
   Gauge covariant fermion propagator in quenched, chirally symmetric Quantum Electrodynamics
   hep-ph/9403252; Phys. Lett. B 333 (1994) pp. 536-544.
   Citations: 44

3. ROBERTS, C. D.
   Electromagnetic pion form-factor and neutral pion decay width
   hep-ph/9408233; Nucl. Phys. A 605 (1996) pp. 475-495 .
   Citations: 82

4. BENDER, A., ROBERTS, C.D. and SMEKAL, L. v.
   Goldstone Theorem and Diquark Confinement Beyond Rainbow-Ladder Approximation
   nucl-th/9602012; Phys. Lett. B 380 (1996) pp. 7-12.
   Citations: 119

5. BENDER, A., BLASCHKE, D., KALINOVSKY, Yu. and ROBERTS, C. D.
   Continuum study of deconfinement at finite temperature
   nucl-th/9606006; Phys. Rev. Lett. 77 (1996) pp. 3724-3727.
   Citations: 53

6. MARIS, P., ROBERTS, C. D. and TANDY, P. C.
   Pion mass and decay constant
   nucl-th/9707003; Phys. Lett. B 420 (1998) pp. 267-273.
   Citations: 102

7. MARIS, P. and ROBERTS, C. D.
   π- and K-meson Bethe-Salpeter amplitudes
   nucl-th/9708029; Phys. Rev. C 56 (1997) pp. 3369-3387.
   Citations: 129

8. IVANOV, M. A., KALINOVSKY, Yu. L. and ROBERTS, C. D.
   Survey of heavy meson observables
   nucl-th/9812063; Phys. Rev. D 60 (1999) 034018, 17 pages.
   Citations: 68

9. BLOCH, J. C. R., ROBERTS, C. D. and SCHMIDT, S. M.
Selected nucleon form factors and a composite scalar diquark
nucl-th/9911068; Phys. Rev. C 61 (2000) 065207 (13 pages).
Citations: 28

10. HECHT, M. B., ROBERTS, C.D. and SCHMIDT, S.M.
Valence Quark Distributions in the Pion
nucl-th/0008049; Phys. Rev. C 63 (2001) 025213 (8 pages).
Citations: 41

NB.
In a 2002 analysis of 63 128 publications in the SPIRES High-Energy Physics Database, Publication 1. in this list:

"Dyson-Schwinger Equations and their Application to Hadron Physics"

was identified as the fundamental reference for the fourth most important research theme in contemporary high-energy and nuclear physics. (143 distinct themes were identified.)

2.3 Citation overview

NB. All citation information is on the public record and compiled from the SPIRES data base:

http://www.slac.stanford.edu/spires/hep/

- Citation Record:

	average citations/article
"Ten Best"	98
All articles	41

- arXiv Comparison

	No. pub. articles in archive	average citations/pub. article
nucl-th archive	6282	12
hep-lat archive	2854	21
hep-ph archive	26089	23

- In counting the citations to published papers written by all the world's *particle and nuclear theorists* and submitted to the SPIRES data base in the 10 years preceding 2002, I rank 228th, with 1603 citations to 52 papers. (The list was prepared in April, 2002.)

  NB. This list identifies only 522 particle and nuclear theorists *worldwide* who have more than 1000 citations to articles they have listed in the SPIRES database and published in the documented period.

2.4 Other evidence of impact on, and major contributions to the field

- **Contributor**:
  - "Key Issues in Hadronic Physics," briefing paper presented at the Hadronic and Electromagnetic Probes Town Meeting, 1-4/Dec./2000, as part of the USA's Nuclear Science Year 2001 Long Range Plan process
- **Member, International Advisory Committee for**:
  - "QCD Down Under," Special Research Centre for the Subatomic Structure of Matter, U. Adelaide, Australia, 10-19 March, 2004
  - "9th International Symposium on Meson-Nucleon Physics and the Structure of the Nucleon (MENU2001)," Washington, DC, on 26-31 July, 2001
  - "International Conference on Nuclear and Particle Physics with CEBAF at Jefferson Lab," Dubrovnik, Croatia, November 3-10, 1998
- **Session Convener**:
  - "9th International Symposium on Meson-Nucleon Physics and the Structure of the Nucleon (MENU2001)," Washington, DC, 26-31 July, 2001
  - "8th International Workshop on Light-Cone QCD and Nonperturbative Hadronic Physics," Lutsen, Minnesota, USA, August 11-22, 1997
- **Organiser of 8 International Meetings**; e.g.,
  - 6-15/Jul/2005: "Light Cone 2005," Cairns, Queensland, Australia
  - 28/Apr-2/May/03: "Symposium on Rare Isotope Accelerator Science," Argonne National Laboratory, Argonne, USA
  - 1-13/Mar/1999: "Understanding deconfinement in QCD", ECT$*$, Trento, Italy. $*$ Proceedings Volume: *Understanding Deconfinement in QCD*, edited by D. Blaschke, F. Karsch and C.D. Roberts (World Scientific, Singapore, 2000) 354 pages.
  - 2-13/Feb/1998: "Nonperturbative Methods in Quantum Field Theory," Special Research Centre for the Subatomic Structure of Matter, University of Adelaide, Adelaide, SA, Australia
- **42 Invited Presentations at International Meetings/Workshops**; e.g.,
  - "Dyson-Schwinger Equations and Observables in Hadron Physics," 10th International Symposium on Meson-Nucleon Physics and the Structure of the Nucleon, Institute of High Energy Physics, Beijing, China, 29/Aug.-4/Sept./2004
  - "Dyson-Schwinger Equations: A tool for hadron physics," 17th International IUPAP Conference on Few-Body Problems in Physics, Triangle Universities Nuclear Laboratory, Duke University, Durham, NC, USA, 5-10/Jun./2003
  - "Confinement and dynamical chiral symmetry breaking," International Conference on Quark Nuclear Physics, Forschungszentrum Jülich, Jülich, Germany, 9-14/Jun./2002

- "Dyson-Schwinger Equations - Aspects of the Pion," DPF 2000, the Annual Meeting of the Division of Particles and Fields of The American Physical Society, Columbus, OH, 9-12/Aug./2000
- "Photo-hadron processes as a probe of bound-state structure," 1996 Gordon Research Conference on Photonuclear Physics, Tilton, NH July 29 - Aug 2, 1996

- **Invited Lecturer at 11 Graduate Student Schools**; e.g.,
  - 3 Lectures: "Dyson-Schwinger Equations: From Gluons and Quarks to Reality" at the Helmholtz International School on Heavy Quark Physics, Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, Dubna, 6-16 June, 2005
  - 5 Lectures: "Hadron Physics and Dyson-Schwinger Equations" at the 20th Annual Hampton University Graduate Studies Program, JLab, Newport News, VA, 31/May–17/Jun. 2005
  - 2 Lectures: "Nonperturbative QCD with Modern Tools," *Graduiertenkolleg* on Particle- and Astro-physics, University of Rostock, Rostock, Germany, 10-28 Apr. 2000
  - 3 Lectures: "Nonperturbative QCD with Modern Tools," 11th Physics Summer School, National Centre for Theoretical Physics, Australian National University, Canberra, ACT, Australia, 12-23 Jan. 1998

- **Coordinator**:
  - Since 1996, Collaborations involving 37 researchers (including 8 PhD students and 1 Diploma student) from 9 countries, including new initiatives with China and Mexico
  - Collaborative Research Agreement between Argonne National Laboratory, and the Department of Physics and Mathematical Physics and the Special Centre for the Subatomic Structure of Matter at the University of Adelaide

3 Complete Lists: Publications, Talks, etc.

3.1 Refereed Articles

1. CAHILL, R.T. and ROBERTS, C.D.
Soliton bag models of hadrons from QCD.
Phys. Rev. D 32 (1985) 2419.

2. ROBERTS, C.D. and CAHILL, R.T.
Dynamically selected vacuum field configuration in massless QED
Phys. Rev. D 33 (1986) 1755.

3. ROBERTS, C.D. and CAHILL, R.T.
A bosonisation of QCD and realisations of chiral symmetry
Aust. J. Phys. 40 (1987) 499.

4. PRASCHIFKA, J., ROBERTS, C.D. and CAHILL, R.T.
A study of $\rho \to \pi\pi$ decay in a global colour model for QCD
Int. J. Mod. Phys. A 2 (1987) 1797.

5. PRASCHIFKA, J., ROBERTS, C.D. and CAHILL, R.T.
QCD bosonisation and the meson effective action
Phys. Rev. D 36 (1987) 209.

6. CAHILL, R.T., ROBERTS, C.D. and PRASCHIFKA, J.
Calculation of diquark masses in QCD
Phys. Rev. D36 (1987) 2804.

7. CAHILL, R.T., ROBERTS, C.D. and PRASCHIFKA, J.
Why baryons are not skyrmions
Aust. J. Phys. 41 (1988) 11.

8. PRASCHIFKA, J., CAHILL, R.T. and ROBERTS, C.D.
Chiral QCD generates constituent quark masses
J. Mod. Phys. Lett. A 3 (1988) 1595.

9. ROBERTS, C.D., CAHILL, R.T. and PRASCHIFKA, J.
The effective action for the Goldstone Modes in a global colour symmetry model of QCD
Ann. Phys. 188 (1988) 20.

10. ROBERTS, C.D., CAHILL, R.T. and PRASCHIFKA, J.
QCD and a calculation of the ω-ρ mass splitting
Int. J. Mod. Phys. A 4 (1989) 719.

11. ROBERTS, C. D., PRASCHIFKA, J. and CAHILL, R. T.
A Chirally Symmetric Effective Action For Vector And Axial Vector Fields In A Global Color Symmetry Model Of QCD
Int. J. Mod. Phys. A 4 (1989) 1681.

12. PRASCHIFKA, J., CAHILL, R. T. and ROBERTS, C. D.
Mesons And Diquarks In Chiral QCD: Generation Of Constituent Quark Masses
Int. J. Mod. Phys. A **4** (1989) 4929.

13. ROBERTS, C. D.
Nonlinear Quantum Mechanics: Two Possibilities
Mod. Phys. Lett. A **5** (1990) 91.

14. ROBERTS, C. D. and MCKELLAR, B. H. J.
Critical Coupling For Dynamical Chiral Symmetry Breaking
Phys. Rev. D **41** (1990) 672.

15. WILLIAMS, A. G., KREIN, G. and ROBERTS, C. D.
Modelling the quark propagator
Annals Phys. **210** (1991) 464.

16. BURDEN, C. J. and ROBERTS, C. D.
Light Cone Regular Vertex In Quenched QED In Three-Dimensions
Phys. Rev. D **44** (1991) 540.

17. BURDEN, C.J., ROBERTS, C.D. and WILLIAMS, A.G.
Singularity structure of a model quark propagator
Phys. Lett. B 285 (1992) 347.

18. ROBERTS, C.D. WILLIAMS, A.G. and KREIN, G.
On the Implications of Confinement
Int. J. Mod. Phys. A 7 (1992) 5607.

19. BURDEN, C.J., PRASCHIFKA, J. and ROBERTS, C.D.
Photon Polarisation tensor and gauge dependence in three-dimensional quantum electrodynamics
hep-th/9303098, Phys. Rev. D46 (1992) 2695.

20. HOLLENBERG, L.C.L., ROBERTS, C.D. and McKELLAR, B.H.J.
Two loop calculation of the ω-ρ mass splitting
Phys. Rev. C 46 (1992) 2057.

21. BURDEN, C.J. and ROBERTS, C.D.
Gauge covariance and the fermion-photon vertex in three- and four-dimensional, massless quantum electrodynamics
hep-th/9303098, Phys. Rev. D47 (1993) 5581.

22. ROBERTS, C.D., CAHILL, R.T., SEVIOR, M.E., IANNELLA, N.
π-π scattering in a QCD based model field theory
hep-ph/9304315, Phys. Rev. D 49 (1994) pp. 125-137.

23. HAWES, F.T., ROBERTS, C.D. and WILLIAMS, A.G.
Dynamical chiral symmetry breaking with an infrared vanishing gluon propagator?
hep-ph/9309263, Phys. Rev. D 49 (1994) pp. 4683-4693.

24. ROBERTS, C.D. and WILLIAMS, A.G.
Dyson-Schwinger Equations and their Application to Hadronic Physics
hep-ph/9403224, Prog. Part. Nucl. Phys., 33 (1994) pp. 475-575.

25. MITCHELL, K.L., TANDY, P.C., ROBERTS, C.D. and CAHILL, R.T.
Charge symmetry breaking via ρ-ω mixing from model quark-gluon dynamics
hep-ph/9403223, Phys. Lett. B335 (1994) pp. 282-288.

26. DONG, Z., MUNCZEK, H.J. and ROBERTS, C.D.
Gauge covariant fermion propagator in quenched, chirally-symmetric quantum electrodynamics
hep-ph/9403252, Phys. Lett. B 333 (1994) pp. 536-544.

27. ALKOFER, R., BENDER A., ROBERTS, C.D.
Pion loop contribution to the electromagnetic pion charge radius
hep-ph/9312243, Intern. J. Mod. Phys. A 10 (1995) pp. 3319-3342.

28. FRANK, M.R., MITCHELL, K.L., ROBERTS, C.D. and TANDY, P.C.
Off shell axial anomaly via the $\gamma^*\pi \to \gamma$ transition
hep-ph/9412219, Phys. Lett. B 359 (1995) pp. 17-22.

29. FRANK, M.R. and ROBERTS, C.D.
Model gluon propagator and pion and rho-meson observables
hep-ph/9508225, Phys. Rev. C 53 (1996) pp. 390-398.

30. ALKOFER, R and ROBERTS, C.D.
Calculation of the anomalous $\gamma\pi^* \to \pi\pi$ form factor
hep-ph/9510284, Phys. Lett. B 369 (1996) pp. 101-107.

31. BURDEN, C.J., ROBERTS, C.D. and THOMSON, M.J.
Electromagnetic Form Factors of Charged and Neutral Kaons
nucl-th/9511012, Phys. Lett. B 371 (1996) pp. 163-168.

32. BENDER, A., ROBERTS, C.D. and v. SMEKAL, L.
Goldstone theorem and diquark confinement beyond rainbow ladder approximation
nucl-th/9602012, Phys. Lett. B 380 (1996) pp. 7-12.

33. ROBERTS, C.D.
Electromagnetic Pion Form Factor and Neutral Pion Decay Width
hep-ph/9408233, Nucl. Phys. A 605 (1996) pp. 475-495.

34. HAWES, F.T., WILLIAMS, A.G. and ROBERTS, C.D.
Renormalization and chiral symmetry breaking in quenched QED in arbitrary covariant gauge
hep-ph/9604402, Phys. Rev. D 54 (1996) pp. 5361-5372.

35. BENDER, A., BLASCHKE, D., KALINOVSKY, Yu.L. and ROBERTS, C.D.
Continuum study of deconfinement at finite temperature
nucl-th/9606006, Phys. Rev. Lett. 77 (1996) pp. 3724-3727.

36. BURDEN, C.J., LU QIAN, ROBERTS, C.D., TANDY, P.C. and THOMSON, M.J.
Ground-state spectrum of light-quark mesons
nucl-th/9605027, Phys. Rev. C 55 (1997) pp. 2649-2664.

37. KALINOVSKY, Yu.L., MITCHELL, K.L. and ROBERTS C.D.
$K_{\ell 3}$ and π_{e3} transition form factors
nucl-th/9610047, Phys. Lett. B 399 (1997) pp. 22-28.

38. IVANOV, M.A., KALINOVSKY, Yu.L., MARIS, P. and ROBERTS, C.D.
Semileptonic decays of heavy mesons
nucl-th/9704039, Phys. Lett. B 416 (1998) pp. 29-35.

39. BLASCHKE, D., ROBERTS, C.D. and SCHMIDT, S.
Thermodynamic properties of a simple, confining model
nucl-th/9706070, Phys. Lett. B 425 (1998) pp. 232-238.

40. MARIS, P., ROBERTS, C.D. and TANDY, P.C.
Pion mass and decay constant
nucl-th/9707003, Phys. Lett. B 420 (1998) pp. 267-273.

41. MARIS, P. and ROBERTS, C. D.
π- and K-meson Bethe-Salpeter amplitudes
nucl-th/9708029, Phys. Rev. C 56 (1997) pp. 3369-3387.

42. BENDER, A., POULIS, G.I., ROBERTS, C.D., SCHMIDT, S.M. and THOMAS, A. W.
Deconfinement at finite chemical potential
nucl-th/9710069, Phys. Lett. B 431 (1998) pp. 263-269.

43. IVANOV, M.A., KALINOVSKY, Yu.L., MARIS, P. and ROBERTS, C.D.
Heavy- to light-meson transition form factors
nucl-th/9711023, Phys. Rev. C 57 (1998) pp. 1991-2003.

44. MARIS, P., ROBERTS, C.D. and SCHMIDT, S.M.
Chemical potential dependence of π and ρ properties
nucl-th/9801059, Phys. Rev. C 57 (1998) pp. R2821-R2825.

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15. HÖLL, ALKOFER, R., A., KLOKER, M., KRASSNIGG, A. AND ROBERTS, C.D.
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3.3 Conference Proceedings

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3. ROBERTS, C.D.
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9. ROBERTS, C.D., IVANOV, M.A., KALINOVSKY, Yu.L. and MARIS, P.
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12. ROBERTS, C.D. and SCHMIDT, S.M.
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16. ROBERTS, C. D.
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18. HECHT, M.B., ROBERTS, C.D. and SCHMIDT, S.M.
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20. ROBERTS, C.D.
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21. ROBERTS, C.D.
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22. HÖLL, A., KRASSNIGG, A. AND ROBERTS, C.D.
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3.4 Books Edited

1. **Understanding Deconfinement in QCD**,
edited by D. Blaschke, F. Karsch and C.D. Roberts
(World Scientific, Singapore, 2000) 354 pages.

3.5 Invited Talks

1. **Research Programmes in the Physics Division at ANL**, presented at the 4th Annual Summer School in Nuclear Physics Research, University of Wisconsin at Madison, 20/June/1991.

2. **Schwinger-Dyson Equations: Dynamical Chiral Symmetry Breaking and Confinement**, presented at the Workshop on QCD Vacuum Structure, American University of Paris, 1-5 June, 1992.

3. **From π-π Scattering to the Quark-Quark Interaction and Hadronic Faddeev Amplitudes**, presented at the inaugural meeting at the European Centre for Theoretical Physics: The Quark Structure of Baryons, Trento, Italy, 4-15 October, 1993.

4. **Can an infrared vanishing gluon propagator confine quarks?** presented at the Workshop on Quantum Infrared Physics, American University of Paris, 6-10 June, 1994.

5. **QCD and π-π scattering**, presented at the Chiral Dynamics: Theory and Experiment Workshop, MIT, 25-29 July, 1994.

6. **Dyson-Schwinger Equations and Hadronic Observables in QCD**, presented at the Joint April Meeting of the American Physical Society and The American Association of Physics Teachers, Washington DC, 18-21 April, 1995.

7. **Hadronic Observables and QCD**, presented at the 1995 Gordon Research Conference on QCD in Nuclear Physics and Astrophysics, Tilton, NH July 24-28, 1995.

8. **QCD at Diverse Length-scales via Dyson-Schwinger Equations**, presented at the Workshop on Nonequilibrium Physics at Short Time-Scales, Max-Planck Gesellschaft Arbeitgruppe: "Theoretische Vielteilchenphysik", University of Rostock, Rostock, Germany, 28/Feb./1996.

9. **Probing QCD at Diverse Length-Scales via the Dyson-Schwinger Equations**, presented at the 6th International Workshop on Light-Cone Physics and Nonperturbative QCD, Ames, IA, 3-14/Jun./1996.

10. **Dyson-Schwinger Equations: Diquark Confinement and Goldstone's Theorem**, presented at the 2nd International Conference on Quark Confinement and the Hadron Spectrum, Como, Italy, 26-30/Jun./1996.

11. **Dyson-Schwinger Equations: Diquark Confinement and Goldstone's Theorem**, presented at the Workshop on Current Problems in Three Body Physics, Max-Planck Gesellschaft Arbeitgruppe: "Theoretische Vielteilchenphysik", University of Rostock, Rostock, Germany, 8-9/Jul./1996.

12. **Photo-hadron processes as a probe of bound-state structure**, presented at the 1996 Gordon Research Conference on Photonuclear Physics, Tilton, NH July 29 - Aug 2, 1996.

13. **Continuum order parameter for deconfinement**, presented at the 25th International Workshop on Gross Properties of Nuclei and Nuclear Excitations, Hirschegg, Austria, 13-18/Jan./1997.

14. **Confinement and Hadron Form Factors**, presented at the Bonn Workshop on Confinement Physics, Institute for Theoretical Physics, University of Bonn, Bonn, Germany, 28/Jul - 8/Aug/97.

15. **Hadrons at extremes of temperature and density**, presented at the Workshop on Nonperturbative Methods in Quantum Field Theory, Special Research Centre for the Subatomic Structure of Matter, University of Adelaide, South Australia, Australia, 2-13/Feb./98.

16. **Probing the QCD running coupling in the infrared**, presented at the Workshop on Physics with 8+ GeV Photons, Carnegie-Mellon University, Pittsburgh, PA 13-14/Mar./98.

17. **Hadron properties at extremes of temperature and density**, presented at the Workshop on QCD at finite baryon density, University of Bielefeld, Bielefeld, Germany 27-30/April/98

18. **Dyson-Schwinger Equations - Connecting small and large length-scales**, presented at the International Conference on Nuclear and Particle Physics with CEBAF at Jefferson Lab, Dubrovnik, Croatia, 3-10/November/1998

19. **Dyson-Schwinger Equations: Confinement and DCSB**, presented at the Worshop on Understanding Deconfinement in QCD, ECT*, Trento, Italy, 1-13/March/1999

20. **Dyson-Schwinger Equations and Hadron Phenomenology**, presented at the Workshop on Light-cone QCD and Nonperturbative Hadron Physics, Centre for the Subatomic Structure of Matter, University of Adelaide, Adelaide, Australia 13-22/Dec./1999

21. **Dyson-Schwinger Equations and Continuum Strong QCD**, presented at the Confinement Research Program, Erwin Schrödinger International Institute for Mathematical Physics" Vienna, Austria, May-Jul./2000

22. **Diquarks and Density**, presented at the Worshop on The Physics of Neutron Star Interiors, ECT*, Trento, Italy, 19/Jun.-7/Jul./2000

23. **Contemporary Applications of Dyson-Schwinger Equations**, presented at Confinement IV: The 4th International Conference on Quark Confinement and the Hadron Spectrum, Vienna, Austria, 3-8/Jul./2000.

24. **Dyson-Schwinger Equations - Aspects of the Pion**, presented at DPF 2000, the Annual Meeting of the Division of Particles and Fields of The American Physical Society, Columbus, OH, 9-12/Aug./2000

25. **Dyson-Schwinger Equations and Few Quark Systems**, presented at the Worshop on Relativistic Dynamics and Few Hadron Systems, ECT*, Trento, Italy, 6-17/Nov./2000

26. **Character of Goldstone Bosons**, presented at the Workshop on Lepton Scattering, Hadrons and QCD, Special Centre for the Subatomic Structure of Matter (CSSM), Adelaide, Australia, 26/Mar-6/Apr./2001

27. **Dyson-Schwinger Equations: From charge radii to deep inelastic scattering**, presented at the 9th International Symposium on Meson-Nucleon Physics and the Structure of the Nucleon, George Washington University, Washington DC, 26-31/Jul./2001

28. **Dyson-Schwinger Equations and Continuum QCD**, presented at the Workshop on Quarks and Hadrons in Continuum Strong QCD, Universität Tübingen, Tübingen, Germany, 3-6/Sept./2001

29. **Goldstone boson's valence quark distribution**, presented at the 11th Light-Cone Workshop – Light-Cone Physics: Particles and Strings, ECT*, Trento, Italy, 3-11/Sept./2001

30. **Confinement and dynamical chiral symmetry breaking**, presented at the International Conference on Quark Nuclear Physics (QNP2002), Forschungszentrum Jülich, Jülich, Germany, 9-14/Jun./2002

31. **Poincaré covariant study of hadrons**, presented at the Argonne Theory Institute Hadron Structure and GeV electroweak interactions, Argonne, IL, 29/Jul.-2/Aug./2002

32. **Pions and the nucleon**, presented at the Workshop on the Structure of the Nucleon, ECT*, Trento, Italy, 2-10/Sept./2002

33. **Aspects of dynamical chiral symmetry breaking**, presented at the 5th International Conference on Quark Confinement and the Hadron Spectrum, Gargnano, Italy, 10-14/Sept./2002

34. **Dyson-Schwinger Equations: A Tool for Hadron Physics**, presented at the Symposium in honour of Jrg Hfner, Ladenburg, Germany, 19-21/Dec./2002

35. **Quark Distributions in the Pion**, presented at the 2nd International Conference on Nuclear and Particle Physics with CEBAF at JLab (NAPP 2003), Dubrovnik, Croatia, 26-31/May/2003.

36. **Dyson-Schwinger Equations: A Tool for Hadron Physics**, presented at the 17th International Conference on Few-Body Problems in Physics, Duke University/TUNL, Raleigh, NC, 5-10/Jun./2003

37. **Pions and the Nucleon**, presented at the Workshop on Aspects of Nonperturbative QCD - Hadrons and Thermodynamics, Physics Department, University of Rostock, 13-16/Jul./2003

38. **Dyson-Schwinger Equations: The Pion and Related Matters**, presented at the Light Cone Workshop: Hadrons and Beyond, Institute for Particle Physics Phenomenology and Grey College, University of Durham, Durham, UK, 5-9/Aug./2003

39. **Confinement, DCSB, Bound States, and the Quark-Gluon Vertex**, presented at QCD Down Under, Special Research Centre for the Subatomic Structure of Matter (CSSM), Adelaide, 10-19/Mar./2004

40. **Dyson-Schwinger Equations and Observables**, presented at the Helmholtz Foundation's Virtual Institute Workshop on Dense Hadronic Matter and the QCD Phase Transition, Bad Honnef, Germany, 2-4/Jul./2004

41. **Dyson-Schwinger Equations and Observables in Hadron Physics**, presented at the 10th International Symposium on Meson-Nucleon Interactions and the Structure of the Nucleon, MENU04, Institute of High Energy Physics, The Chinese Academy of Sciences, Beijing, China, 30/Aug.-4/Sept./2004

42. **A Perspective on Hadron Physics**, to be presented at the Xth Mexican Workshop on Particles and Fields, Institute of Physics and Mathematics, University of Morelia, Morelia, Mexico, 6-12/Nov./2005.

3.6 Invited Lecture Series

1. Series of 2 lectures entitled "*Low Energy Hadron Phenomena*" and "*From a gluon propagator to hadronic observables*" at the Research Workshop on Non-perturbative Methods in Field Theory, National Centre for Theoretical Physics, Australian National University, 1-17 May, 1995.

2. Series of 5 Lectures entitled "*Dyson-Schwinger Equations: Dynamical Chiral Symmetry Breaking, and Hadron Observables*" presented at the 16th UK Institute for Theoretical High Energy Physicists, Swansea, Wales, 4-8 Sept., 1995.

3. Series of 3 Lectures entitled "*Dyson-Schwinger Equations: Dynamical Chiral Symmetry Breaking, and Hadron Observables*" presented at the Graduiertenkolleg: "Struktur und Wechselwirkung von Hadronen und Kernen", University of Tübingen, Sept. 29 - Oct. 4, 1995.

4. Series of 3 Lectures entitled "*Dyson-Schwinger equations in QED and QCD*" presented at the International School on Light-Front Quantization and Non-Perturbative QCD, sponsored by the International Institute of Theoretical and Applied Physics, Ames, IA, May 6 - June 2, 1996.

5. Series of 3 Lectures entitled "*Hadron Physics: Nonperturbative Effects in QCD*" presented at the 13th Summer School in Nuclear and Particle Physics, Robertson, NSW, Australia, 9-14 Feb. 1997.

6. Series of 5 Lectures entitled "*Nonperturbative effects in QCD at finite temperature and density*" presented at the Research Workshop on Deconfinement at Finite Temperature and Density, Dubna, Russia, 1-25 Oct. 1997.

7. Series of 3 Lectures entitled "*Nonperturbative QCD with Modern Tools*", presented at the 11th Physics Summer School, National Centre for Theoretical Physics, Australian National University, Canberra, ACT, Australia, 12-23 Jan. 1998.

8. Series of 2 Lectures entitled "*Nonperturbative QCD with Modern Tools*", presented in the *Graduiertenkolleg* on Particle- and Astro-physics, University of Rostock, Rostock, Germany, 10-28 Apr. 2000

9. Series of 2 Lectures entitled "*Unifying light- and heavy-quark physics*, presented at the International School on Heavy-Quark Physics, Bogoliubov Laboratory for Theoretical Physics, Joint Institute for Nuclear Research, Dubna, Russia, 27/May-5/Jun./2002

10. Series of 5 Lectures entitled *Hadron Physics and Dyson-Schwinger Equations*, to be presented at the 20th Annual Hampton University Graduate Studies Program, JLab, Newport News, VA, 31/May-17/Jun. 2005

11. Series of 3 Lectures entitled *Dyson-Schwinger Equations: From Gluons and Quarks to Reality*, to be presented at the Helmholtz International School on Heavy Quark Physics, Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, Dubna, 6-16 June, 2005