Professor Anders E. Bondeson

December 12, 1953 – March 20, 2004

Anders' death is a very great loss to the Swedish, European and international fusion programmes - and the suddenness is a great shock.

– David Campbell

I am very sad to hear of Ander's death. He will be a loss to fusion. His cheerful personality always made him a good companion at meetings as well.

– Rob La Haye

I'm very sad to hear about Anders' premature departure. Anders was one of the brightest star of his generation in the plasma physics firmament.

– Alex Pletzer

I am deeply saddened to hear of the untimely death of Anders. I considered him to be one of the leading scientists of his generation and a gentle person with dignity.

– Janardham Manickam

Anders is a very respectable scientist, he has real impact to the plasma physics and fusion in the world.

– Ming-sheng Chu

I have never imagined that we will lose one of our most intimate colleagues while we are working hard to prove his extremely original concept.

– Michio Okabayashi

This is a great loss for all who knew Anders. This is a great loss for the fusion studies. All physicist of ITER International Team are deeply regret of the death of Anders.

– Yuri Gribov

Scientific career of Anders Bondeson ...

- 1975 – 1979: Chalmers University of Technology, Sweden
- 1979 – 1982: University of Maryland, USA
- 1982 – 1985: Chalmers University of Technology, Sweden
- 1986 – 1993: CRPP Lausanne, Switzerland
- 1993 – 1995: Uppsala University, Sweden
- 1995 – 2004: Chalmers University of Technology, Sweden

... started at CHALMERS, and untimely ended at CHALMERS.

1975-1979, Chalmers

- PhD student under Profs. Dan Anderson and Mietek Lisak
- Basic plasma science, nonlinear waves, solitons
- 1976, first known paper on wave interactions in random media, with Prof. D. Anderson
- Together with Profs. D. Anderson and M. Lisak, developed well-known work on variational approach to perturbed solitons
- 1978, a joint work with Prof. Jan Weiland on Korteweg De Vreies soliton in Physics Letters A
- 1979, first PRL paper on transverse instability of Langmuir solitons in EM fields
- In 7 joint papers and about 10 conference contributions with Profs. D. Anderson and M. Lisak, developed a general soliton perturbation theory as well as studied the soliton stability in nonlinear systems

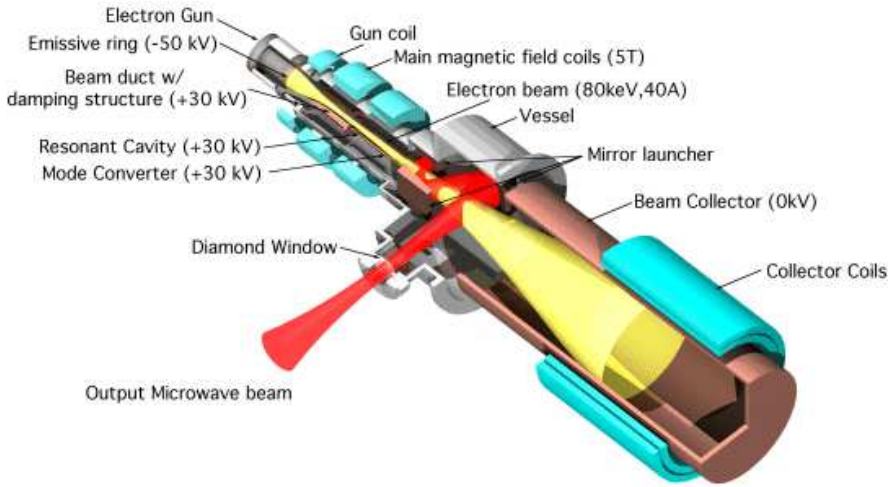
1979-1982, Maryland (I)

- **Research associate – Assistant professor, worked on various topics: from basic nonlinear MHD to gyrotrons**
- **Important theoretical work on tilting instability in spheromak (PF'81), also later work with Dr. P.N. Guzdar on the influence of magnetic reconnection and shear flow on spheromaks (PF'85), play major role in constructing spheromak experiment in PPPL**

- **Another well cited work on Taylor relaxation in compact torus, with Dr. S. Riyopoulos (PF'82)**

1979-1982, Maryland (II)

- **Started theoretical work on quasi-optical gyrotrons as high-power millimeter wave generators, well-known paper on multimode theory and simulation of gyrotrons published in International Journal of Electronics 1982.**



- **Continued study of quasi-optical gyrotrons until early 90s, when he worked in CRPP Lausanne, coholder of 4 patents on gyrotrons**
- **Started work on tearing modes and stability of magnetic islands, and published results when he came back to Chalmers**

1982-1985, Chalmers (I)

- **Extra Professor of theoretical fusion plasma physics, kept close relationship with Maryland, visited UCSB, Institute of Theoretical Physics and Princeton**
- **Developed basic theory work on tearing modes, including:**
  - **1983, 2nd PRL paper, showed that 3D equilibria with magnetic islands may be ideally unstable**
  - **1983, stability of tearing modes as pairwise-coalescing islands (coalescence instability)**
  - **Well known work with Prof. Mikael Persson on influence of parallel and perpendicular plasma flows on tearing modes (PF'96)**
  - **Work with Dr. R.G. Kleva and Prof. J.F. Drake (PF'84'85) on nonlinear destabilization of tearing modes and influence of mass flow**
  - **Self-consistent simulation of of disruptions triggered by 2/1 tearing mode (NF'98)**

1982-1985, Chalmers (II)

- **1985, published another very well cited PRL paper (nearly 100 times) on Schrödinger equations, together with colleagues from UCSB**

- **1985, published a less known, but very important work (PF'85) on Alfvén cascade in 2D incompressible MHD**

- **Continued actively theoretical study of gyrotrons, collaborated with Prof. Tran (IJE'84'86)**

1986-1993, CRPP (I)

- **Invited Professor – Adjoint Scientifique at CRPP: stability of plasmas with flow, disruption theory, numerical codes CHEASE and MARS, rotational stabilization of RWM**

- **Continued tearing mode study, three important papers with Prof. Mikael Persson:**
  - **Tearing mode stabilization by wall and rotation, and qa($<$2) limit disruption (NF'88)**
  - **Density limit disruption due to wall locking of tearing modes (NF'89)**
  - **Oscillating islands in rotating plasmas (PF'90)**

- **Developed important theoretical work on plasma stability with flow in a cylinder: local Suydam mode with shear flow (PF'87), ideal stability with flow – MHD vs. guiding center model (NF'88)**

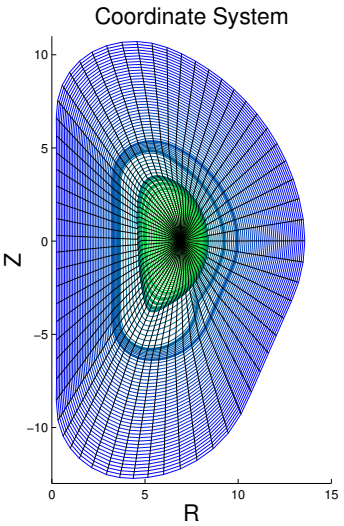
1986-1993, CRPP (II)

- **Solved nonlinear reduced MHD + a transport model, used for sawteeth simulation (NF'89, with Dr. G. Vlad), modeling of density limit disruption (NF'91, well known), density limits and disruptions on TCV (NF'92, expt. work with Dr. Z.A. Pietrzyk)**

- **Constructed two very accurate and widely used numerical codes for toroidal MHD: CHEASE (CPC'92) and MARS (PF'92)**

  – **CHEASE:**

  an equilibrium code solving Grad-Shafranov equation,
  very accurate by using cubic Hermite elements,
  work mainly with Dr. H. Lütjens,
  plus later additions from Prof. O. Sauter, Y.Q. Liu, etc,
  output interface to many stability codes



1986-1993, CRPP (III)

- **MARS:**

  linear stability code, single-fluid resistive/ideal MHD,

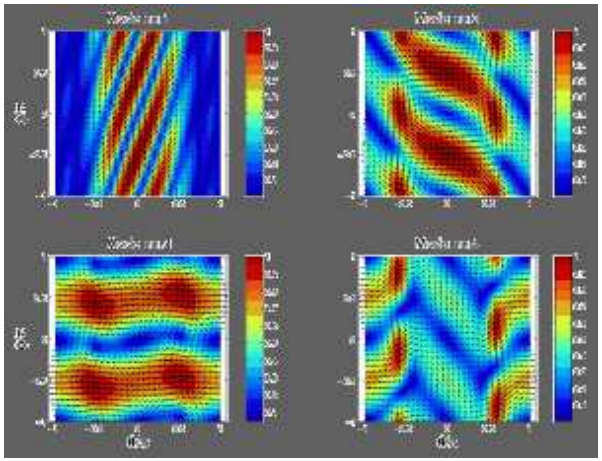
  originally written by A. Bondeson, later significant additions by

  Dr. M.S. Chu (plasma flow, PoP'95),

  Dr. D.H. Liu (improved poloidal convergence, CPC'99),

  Y.Q. Liu (feedback, time-stepping, etc., PoP'00),

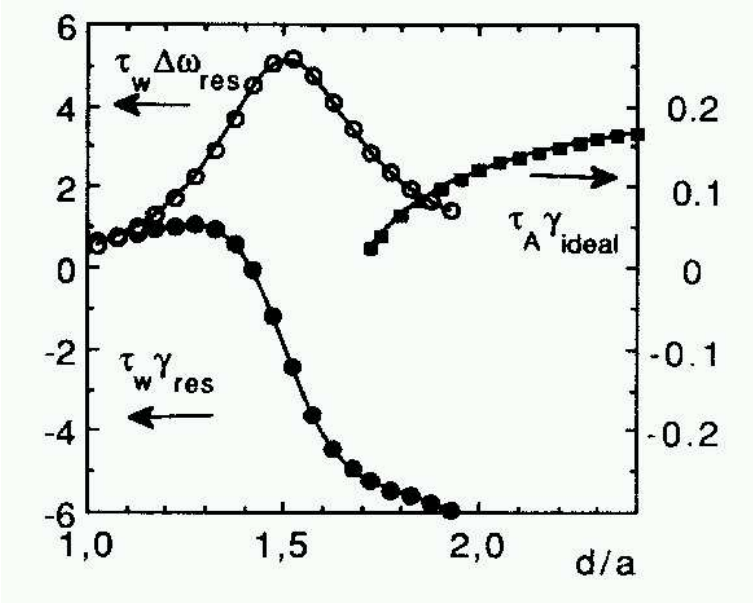
  Implemented tunable integration (CPC'92) for FEM in MARS – a special numerical technique to improve accuracy and this idea was proven very useful when developed a CEM code for solving Maxwell's equations.



- **With MARS, he obtained very interesting toroidal results of shaping effects on resistive (PF'92) and ideal (NF'92) internal kinks, as well as kinetic effect on internal kinks (PRL'93, PF'93, with Prof. T.M. Antonsen Jr.)**

1986-1993, CRPP (IV)

- **With MARS, he showed that RWM can be stabilized by rapid plasma toroidal rotation, provided that the rotation speed is a few percent of Alfvén speed, sound wave damping plays important role (PRL'94, with Dr. D.J. Ward). This is one of his most important scientific achievements. This theory on RWM has now been confirmed by DIII-D experiments. Up to now, this PRL paper has been cited 151 times.**



- **Other scientific activities include continuation of gyrotrons study (PF'90, PF'93 with Prof. T.M. Antonsen Jr.), MHD stability of RFP plasmas (NF'91, with Dr. R. Paccagnella, Physics Script'93, with Dr. M. Benda)**

1993-1995, Uppsala

- **Professor of Theoretical Electrotechnics: application of MARS, basic plasma theory**
- **Collaborated with Dr. M.S. Chu from General Atomics, USA, added shear plasma flow into MARS (PoP'95 with M.S. Chu), very well known and frequently cited work**
- **Collaborated with Prof. Vladimir R. Pavlenko on drift waves excited by plasma rotation (PoP'95)**
- **Continued working on tearing modes(PoP'95, PoP'96 with Dr. H.X. Xie), and RFP MHD modes with wall and rotation (PoP'95 with Dr. Z.X. Jiang)**

1995-2004, finally Chalmers (I)

- **Professor of Electromagnetic Field Theory**

- **Continued collaboration with Dr. M.S. Chu, published three important papers on: resistive interchange in NCS plasmas (PRL'96, well known), cylindrical calculations for kinetic damping of RWM (PoP'96, a significant step towards improving RWM theory), rotational stabilization/destabilization of various MHD modes (NF'99).**

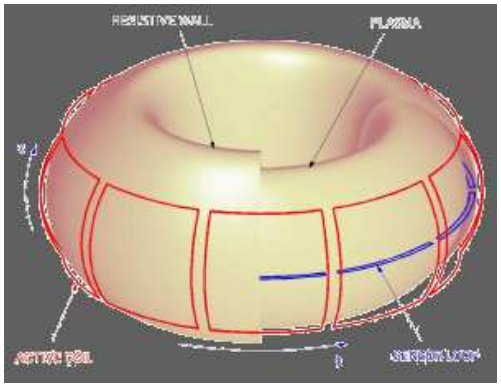
- **Very active collaboration with Prof. Christer Wahlberg on MHD stability analysis using computer algebra, including very interesting work on stability of ideal internal kink (JPP'97), rotational stabilization of internal kink (PoP'00), Mercier modes stabilization by sonic rotation (PoP'01)**

1995-2004, Chalmers (II)

- **Worked very actively on advanced tokamaks, brought significant impact to this principle along two fronts:**

  1) MARS study of MHD beta limits for advanced tokamaks (NF'97, NF'99), work together with Prof. M. Persson.

  2) Feedback control of RWM for advanced tokamaks, both theory and MARS computations (PRL'00, NF'01, PPCF'02, NF'02, PoP'02, PPCF'03, NF'04), work together with Y.Q. Liu.



- **Also worked on theory of active control of RWM in RFP, together with Drs. R. Paccagnella and D. Gregoratto. This activity is still going on in collaboration with RFX, Padova and EXTRAP-T2R, Stockholm (Prof. J.R. Drake, Dr. P.R. Brunsell et al.).**

- **Continued theoretical work on rotational stabilization of RWM: both cylindrical theory (PoP'97) and toroidal theory (PoP'99).**

Summary of activities in Fusion and Plasma Physics

- **Basic plasma science: magnetic relaxation, Alfvén cascade, etc**
- **Nonlinear waves, Schrödinger equations, solitons**
- **MHD in tokamaks:**
  - **Tearing modes ($+$flow)**
  - **internal kinks ($+$flow)**
  - **external kinks ($+$flow)**
  - **Disruptions, nonlinear MHD**
  - **Advanced tokamaks, increase beta by stabilizing ideal external kink (plasma rotation or feedback)**
- **MHD in RFP: stability of ideal/resistive modes, control of RWM, etc.**
- **MHD in spheromaks: tilting modes, influence of magnetic reconnection and shear flow, etc.**
- **Numerical codes: CHEASE and MARS**
- **Gyrotrons study**

Summary of activities in Computational Electromagnetics

- **Proposed first strictly stable FEM-FDTD hybrid scheme for solving 3D high-frequency Maxwell's equations (CPC'00, JCP'02, IEEE Trans. Antennas Propagat.'02), together with Dr. Thomas Rylander. This work is becoming well recognized.**

- **Developed efficient formulations for eddy current computations using edge elements (IEEE Trans. Magn. '02,'03), together with Y.Q. Liu etc.**

- **Accurate Padé approximation schemes (Int. J. Numer. Model.'03), with Pär Ingelström**

- **Developed a new efficient procedure for shape and material optimizations in electromagnetic applications (IEEE Tran. Magn. '03), together with Yongtao Yang**

- **Other CEM activities that are still going on in his group**

Summary

Professor Anders Bondeson published more than 100 journal papers, gave more than 30 invited talks on international conferences.

He was a world leading figure in plasma physics and fusion energy research, a highly respected MHD theorist by his community. During his career, he made impressive advances not only on analytical theory, but also on numerical computations for fusion plasmas. He had a unique ability to grasp and solve the problems in great depth. Scientists around the world express their sorrow and deeply regret the loss of this brilliant mind who has had a strong impact in the world of fusion. His contributions to CEM were also indeed of great significance and originality.

One of Anders' distinguishing features was an admirable ability to identify the important problems and to approach these with an open mind. Apart from being an excellent researcher who stood for the very highest academic values, Anders was a good friend with a cheerful and honest personality for many of his colleagues, who now feel a profound grief as they have lost a dear companion.