Biography for Professor Heinrich Hora

Citation

Professor Hora is an internationally respected authority on laser driven fusion energy since the beginning in 1962 at the Max-Planck Institute of Plasma Physics in Garching/Germany and since 1975 at the chair of Theoretical Physics of the University of New South Wales in Sydney/Australia and continued in his Emeritus position from 1992. His computations led to the first formula for the optimized fusion gains and on optical constants in plasmas based on the classical collision frequency for absorption. Analyzing measurements of laser produced ion emission from plasmas led him to the conclusion of nonlinear effects where the generation of anomalously energetic ions led to the formulation of the nonlinear force of direct conversion of laser energy into mechanical motion of plasma. These forces cover the optical plasma properties and are a generalization of the long known ponderomotive force. With this he derived the ponderomotive self-focusing to explain why laser powers above megawatt cause the change into the nonlinear regime (1970). His relativistic derivation of the optical constants led to the first general derivation of relativistic self-focusing (1975).

The fusion gain formulas were generalized for self-heat and arrived at the discovery of volume ignition (1978) confirmed later by John A. Wheeler as "Wheeler modes". Against strong opposition he demonstrated that electrons in vacuum can be accelerated by laser light due to the nonlinear property of the interaction (1988). Evaluation of experiments led to the recognition of longitudinal fields in laser beams showing the "nonlinearity principle" changing theory in linear physics from totally wrong into the correct nonlinear result. His first theory of electron modulation of electrons by lasers in presence of materials (Schwarz-Hora effect 1969) led to the correspondence principle of electromagnetic interaction and the later conclusion of non-locality. His earlier results of the generation of plasma blocks by nonlinear force acceleration were confirmed experimentally not before 1996 by Sauerbrey's Doppler measurements using extremely clean and very powerful laser pulses of picoseconds duration. These plasma blocks for ignition of low compressed fusion fuel permitted the first application of the Bobin-Chu scheme of fusion for "nuclear energy without dangerous radiation" which received special attention 2010, explained in a British interview by a Leader of the National Ignition Facility as having "the potential to be the best route to fusion energy".

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PROFESSOR HEINRICH HORA

Heinrich Hora was born in 1931 in Bodenbach/Elbe, South of Dresden, and went to high schools in Aussig/Elbe and Altenburg/Thüringen. After studying Theoretical Physics at the University of Halle/Wittenberg and finishing his PhD (Dr.rer.nat.) at the University of Jena in 1959, he worked in South Germany until 1975. His activities were in several industry research centers (Zeiss, IBM, Westinghouse at Pittsburg PA and Siemens) mostly on problems of solid state physics for transistors and optical detectors including the first publication about diamond growth by physical vapor deposition (IBM patent). Since 1962 he focuses on the theory of lasers and plasmas for fusion energy at the Max-Planck-Institute in Garching near Munich. From 1969-75 he was Adjunct Associate Professor at the Rensselaer Polytechnic Institute in Hartford CN where he founded and was co-director of the international conference series "Laser Interaction and Related Plasma Phenomena" continued since 1997 by a legally established international directorate as "Fusion Science and Applications". This is the dominant bi-annual meeting in the field e.g. with more than 600 contributions and 600 participants in San Francisco Sept. 2009. In cooperation with the American Nuclear Society the Edward Teller Medal is awarded worldwide.

In 1975 he was appointed Foundation Professor of Theoretical Physics and Head of the Department of Theoretical Physics at the University of New South Wales until 1992 becoming Professor Emeritus for continuing his research also as Adjunct Professor at the University of Western Sydney and PhD thesis supervisor overseas cooperating with IAEA in Vienna/Austria.

Invited by Cambridge University Press, he founded the Journal "Laser and Particle Beams" in 1982, serving as Editor-in-Chief until 1992. He held visiting professorships at the Universities of Rochester NY, Bern, Weitzmann Institute, Iowa, Giessen, Darmstadt and Osaka, as Attaché at CERN 1990-92, and full-time as Konrad-Zuse-Professor of Electrical Engineering in 1993-96 in Regensburg/Germany.

In all, Professor Hora has supervised 23 PhD students, published 9 books as sole author and 2 others as co-author. His department at UNSW, from 1975-1992, achieved outstanding results in publications and honours students (B.Sc. in Theoretical Physics), producing several University Medallists. He founded the Dirac-Fund at the University of New South Wales to commemorate his initiated visit of Paul Dirac to Australasia in 1975.

Professor Hora is still involved in international research projects in association with conferences and other consultancies. His more than 500 publications and 58 granted patents (12 in the USA) received more than 3000 citations.

Among his achievements, Professor Hora lists his discovery of the anomalous vector effect of photoemission, the first theory on the modulation of electron beams by lasers (Schwarz-Hora effect), the correspondence principle for electromagnetic interaction, the derivation of the nonlinear (ponderomotive) force, the first quantum theory of surface tension in metals, the derivation of magic numbers of nuclei from astrophysics and low energy nuclear reaction measurements, and a new laser fusion scheme with block ignition. This was worldwide highlighted as "Fusion Energy without any dangerous Radiation" in 2010.

Professor Hora was awarded a Doctor of Science from the University of New South Wales in 1981. He is a Fellow of the Australian Institute of Physics and of the Institute of Physics (London) and Vice-President of the Royal Scoiety of New South Wales. He received the Ritter von Gerstner Medal, the Edward Teller Medal, the Dirac Medal and the Ernst Mach Medal. He was also awarded the German Sports Gold Medal. His hobbies are: swimming, playing piano and golf. With his wife Rose, dec. 2007, he has 6 children and 16 grandchildren.

Highlights of scientific results by Heinrich Hora (Mai 2011)

(1) Based on the predicted laser driven plasma blocks by the nonlinear (ponderomotive) force [10][11][28] and the experimental proof by Sauerbrey (1996) and others, ignition of **uncompressed nuclear fusion fuel** was evaluated for **NUCLEAR ENERGY WITHOUT DANGROUS RADIATION** using hydrogen-boron(11) fuel [35].

(2) Volume ignition for nuclear **fusion** at radially compressed plasma (confirmed and later interpreted as "**Wheeler modes**") [9][16][17].

(3) Derivation of the **nonlinear (ponderomotive) force** at laser-plasma interaction including dielectric plasma properties [10] leading to the **universal equation of motion** in plasmas [11].

(4) First theory of **electron acceleration by lasers in vacuum** based on nonlinear interaction [25][26].

(5) Clarification of the **Richardson equations** with deriving the **volume photo effect** and a universal spectral gain curve [2] generalized to the fact that the **fermionic state of electrons is impossible** for temperatures above $2mc^2$ due to strong coupling to the Planck radiation [2][3].

(**6)** Theory of quantum modulation of electron beams by laser interaction within solids or molecules (**Schwarz-Hora effect** 1969) by which way the **correspondence principle for electromagnetic interaction** was derived [12] [13] and later applied to inverted Rydberg states of ultrahigh density clusters [32][33].

(7) Derivation of megawatt laser threshold for **ponderomotive self-focusing** [14] and of the general dielectric mechanisms for **relativistic self focusing** of laser beams in plasmas [15].

Scientific Achievements by Heinrich Hora (January 2011)

9Bold numbers in brackets refer to preceding page)

1955 Proof that there is **no internal reflection** at propagation of electromagnetic waves in inhomogeneous media from exact result using Rayleigh profiles in contrast to all leading authorities (Ginzburg, Stratton, Försterling etc.) [1]. This fact was confirmed as a remarkable curiosity by Osterberg (J. Opt. Soc. Am. 48, 513 (1958)) for general profiles.

(5) 1955/6 Clarification of essential difference between thermionic and photoelectric Richardson equation with general expression of spectral property of **photoelectric quantum yield** based on solution of an integral equation [2]. Subsequent results proved that **electrons are not longer Fermions** at temperatures above mc^2 [3] (Thesis Univ. Halle-Wittenberg Febr. 1956, Diplom-Physiker) confirming volume photo-effect against Herbert Fröhlich's or Igor Tamm's surface photo effect.

1959 Discovery of the **anomalous vector effect** of photoemission in contrast to the authority of R.W. Pohl (Dr.rer.nat. Thesis Univ. Jena) [4].

1960 Discovery of anomalous temperature dependence of photoemission of electrons [5] clarified as modification of the work function by filling of surface traps [6] in agreement with later measurements by Nicholaas Bloembergen et al (Appl. Phys.A 36, 143–150. (1985)) with first quantum effect for **photoemission in the far infrared**.

1961 First measurement of **sub-threshold** generation of **crystal defects** by electron bombardment in silicon [7] leading to low cost and clean generation of solar cells [8].

1964 Laser driven deuterium-tritium nuclear **fusion gain formula** for volume burn (disclosed after de-classification) [9].

(3) 1967 Generalization of the ponderomotive force as "nonlinear force" for plasmas by inclusion of dielectric response of plasmas [10] needing the addition of nonlinear and electric terms to Schlüter's two-fluid plasma theory arriving at the complete gauge and Lorentz invariant formulation [11].

(6) 1969 First and following theory for the quantum modulation of electron beams by laser at interaction within solids (Schwarz-Hora effect) as reported in News and Views of Nature [12] based on a correspondence principle of electromagnetic interaction [13].

(7) 1969 Complete derivation of ponderomotive self-focusing of laser beams in plasmas explaining the threshold for nonlinearity above about MW laser power [14].

(2) 1975 General derivation with visible understanding of relativistic self-focusing [15] due to relativistic change of the electron mass at quiver motion.

1978 Laser driven deuterium-tritium nuclear fusion with alpha-self-heat and partial bremsstrahlung re-absorption for spherical compression: discovery of volume ignition [16] confirmed 1981 by "Wheeler

modes": John A. Wheeler & Kirkpatrick (Nucl. Fusion 21, 389) and Lackner, Colgate et al. *Laser Interaction and Related Plasma Phenomena* AIP Conf. Proceed. No. 318 p.356 [17].

1979 Explanation of the Boreham experiment [18] of lateral electron acceleration from a laser focus (as consequence of the nonlinear force action [10]) with the subsequent derivation of the *longitudinal electric field of optical beams* of finite size as Maxwellian exact results [19] parallel to the discovery by Melvin Lax et al (Phys. Rev 11A, 1365 (1978)) of the curiosity of longitudinal electric fields in microwaves. Proof by polarization dependence of the lateral electron emission [18,19]. Consequence is that nonlinear physics needs most precise linear physics and will open the systematic discovery of a new dimension of phenomena [20].

1982 Development of the first genuine two-fluid hydrodynamic description of plasmas including the dynamic internal electric fields leading to the discovery of general dynamic electric double layers in laser produced plasmas [21] with generalization to the first quantum theory of surface tension in metals [22] and for nuclear surfaces defining the confinement of nucleons in nuclei reproducing the measured nuclear densities and the transition into quarks at 6 times higher than nuclear densities due to the change of the nucleons into relativistic Fermi-Dirac statistics [23]. Application of the genuine two-fluid hydrodynamics for explanation of the 20-picosecond stochastic pulsation of laser-plasma interaction and suppression by beam smoothing [24].

(4) 1988 Against the general believe that electrons cannot be accelerated by laser in vacuum, the nonlinear property of interaction does lead to violent acceleration as also reported in News and Views of Nature and in the BBC World service [25] leading to a new direction of electron accelerators [20,26].

1993 The extremely rare results on "cold fusion" - which were acceptable for physicists - could be used [27] to conclude a nuclear reaction in picometer distance with kilosecond probability (like K-shell capture) fitting Miley's measurements of low energy nuclear reactions LENR explaining a Boltzmann probability exactly as the element distribution in the Universe with a basically new derivation of the magic numbers of nuclei. Miley's measurement of local maxima in the distribution could be identified as being caused by Maruhn-Greiner excitation similar to uranium fission. Coulomb screening for the deuteron gas was calculated to be three times higher than in usual plasmas in agreement with later measurements (Huke, K., Cerski, P. et al. *Phys. Rev. C 78*, 015803 (2008); *Europhysics Letters*, *54*, 449 (2001)) .

2002 An explanation was given for strong anomalies measured with TW-ps laser pulses with very high contrast ratio, using plane geometry computations [28] concluding nonlinear force driven plasma blocks with low temperature and highly directed ion energies with space charge neutral ion current densities exceeding 10^{10} Amps/cm^2 as later confirmed experimentally.

(1) 2008 Application to side-on ignition of solid state density DT fusion may result in energy gains of 10,000 [29]. Application to fusion of solid density hydrogen-boron(11) with dozens of petawatt ps laser pulses may be about ten times more difficult than DT fusion only [30] [35] [36] while fusion with spherical laser compression is about 100,000 times more difficult and was excluded before, though a partial relaxation of these difficult conditions was opened by a resonance effect [38].

2008 (1992) Using PW-ps laser pulses in the collision area of the LHC should permit a very detailed time dependence measurement of the B-meson generation and the decay process [31][32] .

2009 Application of crystal physics [33] to analyze measurements by Lipson, Miley et al and by Holmlid et al may confirm the possibility to prepare solid state fusion targets with 1000 times and much higher solid state deuterium density. The essential mechanism for the inverted Rydberg matter for the ultra-dense deuteron clusters D(-1) can be explained by a quantum modified Bohr model with orbital quantum number $\ell = 1$ [34] as Bose-Einstein condensation at room temperature [37].

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HIGHLIGHT:

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