Arbeitsgebiete und Publikationen von Eckart Marsch

Quantenphysik der Kondensierten Materie (Korrelationen, Magnetismus und Transport im Festkörper; 1974–1978)

Kurzfassung des Inhalts

Die Arbeiten zur Physik der Kondensierten Materie sind im Rahmen meiner Diplom- und Doktorarbeit entstanden. Sie beschäftigen sich mit elektronischen Korrelationen (durch Coulomb Wechselwirkung) in engen Leitungsbändern von Übergangsmetallen (wie Fe, Co und Ni), und mit dem Magnetismus und elektronischem Transport (beschrieben durch thermodynamische Responsefunktionen) in solchen Materialien. Die zugrundeliegende Theorie basiert auf dem Hubbard-Modell. Nach der Entdeckung der Hochtemperatursupraleitung entstand noch die Arbeit über "Antiferromagnetism and High-Temperature Superconductivity".

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Physik des Sonnenwindes (Phänomenologie, Modelle, Kinetik, Turbulenz, Coulomb-Stöße, und Welle-Teilchen Wechselwirkungen; 1976-2017)

Kurzfassung des Inhalts

Die Arbeiten zur Physik des Sonnenwindes befassen sich seiner Phänomenologie und seinen Modellen im Rahmen der Flüssigkeitsbeschreibung aber auch im Detail mit dem Mikrozustand des Sonnenwindes. Erforderlich dafür sind ein tiefes Verständnis der Plasma-Kinetik und -Turbulenz, und der Coulomb-Stöße zwischen Ionen und Elektronen, sowie der Welle-Teilchen Wechselwirkungen im Plasma des interplanetaren Raumes. In den Arbeiten steht die Auswertung von Meßdaten von Raumsonden (insbesondere von der Helios Mission) im Mittelpunkt zusammen mit ihrer theoretischen Interpretation. Die aufgelisteten empirischen Arbeiten umfassen ein sehr breites Spektrum von Themen und Methoden, mit dem Ziel die Eigenschaften und Dynamik des Sonnenwindes umfassend zu verstehen. Einige Arbeiten mit den dort beschriebenen Geschwindigkeits-Verteilungsfunktionen der Ionen und Spektren der magnetohydrodynamischen Fluktuationen von Strömungs- und Magnetfeld (sowie der radialen Gradienten) waren bahnbrechend für die moderne Weltraumplasmaphysik. Ein Reviewartikel zur Turbulenz wurde zum Klassiker der Sonnenwindliteratur.

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Physik der Sonnenkorona (EUV Spektroskopie, Koronale Quellen des Sonnenwindes, Plasmakinetik und Plasmawellen in der Korona; 1994–2013)

Kurzfassung des Inhalts

Die Arbeiten zur Physik der Sonnenkorona befassen sich mit der EUV Spektroskopie der Übergangszone und Korona der Sonne sowie mit den Quellen des Sonnenwindes im chromosphärischen Netzwerk. Dabei werden die Daten im Rahmen der Plasmakinetik und im Bezug auf Plasmawellen in der Korona ausgewertet und unter Berücksichtigung des exptrapolierten Magnetfeldes der Korona analysiert und interpretiert. Die Entstehung des Sonnenwindes in den Funnels (Magnetfeldtrichtern) des Netzwerkes in koronalen Löchern ist eine grundlegende Entdeckung, die in einigen empirischen Arbeiten (aber auch in Modellen) beschrieben wird. Modellrechnungen zur Element-Fraktionierung in der Chromosphäre werden vorgestellt. Die kinetische Plasmaphysik der Sonnenkorona wird in einem vielzitierten Übersichtsartikel diskutiert. Zwei umfangreiche Reviews beschreiben Ergebnisse, experimentelle und methodische Aspekte sowie instrumentelle Grundlagen der solaren Ultraviolett-Spektroskopie.

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Theoretische Weltraumplasmaphysik (Kinetik, Turbulenz, Plasmawellen, 1980–2015)

Kurzfassung des Inhalts

Die Arbeiten im Rahmen der theoretischen Weltraumplasmaphysik befassen sich mit Themen aus der Plasmakinetik, der magnethydrodynamischen und kinetischen Turbulenz, sowie zu Wellen im Plasma in seiner Beschreibung als Flüssigkeit oder als vielkomponentiges kinetisches Medium. Es werden Transporteigenschaften durch Coulombstöße sowie Welle-Teilchen Wechselwirkungen berechnet. Analytische Methoden und numerische Simulationen werden zur Untersuchung von Turbulenz und ihrer Energiekaskade verwendet. Insbesondere wird die Dissipation von Turbulenz (einhergehend mit Heizung und Beschleunigung von Teilchen) diskutiert. Die Dispersionseigenschaften verschiedener Wellen werden analysiert und der Zerfall großamplitudiger Alfvénwellen erforscht und simuliert. Aspekte der Intermittenz im Plasma werden ebenfalls untersucht.

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Relativistische Quantenmechanik und Quantenfeldtheorie (Wellengleichungen und Eichfeldtheorie; 2005–2017)

Kurzfassung des Inhalts

Diese theoretischen Arbeiten beschäftigen sich mit relativistischen Gleichungen für geladene elementare massive Teilchen im Rahmen der Quantenmechanik und der Quantenfeldtheorie. Die Eigenschaften der Dirac- und Majorana-Gleichung werden tiefer analysiert und unter neuen Gesichtspunkten diskutiert. Das Wasserstoffatom wird als binäres relativistisches System (mit Isotopeneffekt) erneut berechnet. Auf der Basis der SU(N) (mit N=2,4,8) Gruppentheorie und der inneren Symmetrien der Dirac-Gleichung wird eine neue vereinheitliche Feldtheorie für fundamentale Fermionen und Bosonen vorgeschlagen.

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