The **Instituto de Estructura de la Materia (IEM)** was founded in 1976 to advance the knowledge of the **structure of matter at an ample range of physical scales**, from the building blocks of matter and space time, to nuclei, atoms, molecules, and macromolecules, including condensed matter and mesoscopic systems.

**STAFF:**

<table>
<thead>
<tr>
<th>PLAN</th>
<th>Dec 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>6</td>
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<tr>
<td>Support</td>
<td>10</td>
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<tr>
<td>Scientific</td>
<td>100</td>
</tr>
<tr>
<td>TOTAL</td>
<td>116</td>
</tr>
</tbody>
</table>
Owing to the **seminal** character of IEM, it would be difficult to understand the configuration of the Physics Area in CSIC without the Institute.

A research line in **Astrophysics**, active until now at the Institute, is in a process of reallocation in the framework of this Plan of Action. During the last Plan of Action of the Institute, 4 **new tenured scientists** joined that research line at IEM.

Although included in the online application, the Plan of Action for the line “**Formation and Evolution of Galaxies**” is totally independent of the rest of the Institute.

IEM is part of the **Centre of Physics Miguel A. Catalán**. Except the **Management Office**, all services belong to the Centre.
**Research Lines (1)**

- **Gravitation & Cosmology (Staff: 10)**
  - CONSOLIDER CPAN. Emergent.

- **Nuclear Physics (Staff: 20)**
  - Experimental Nuclear Physics
  - Theoretical Nuclear Physics
  - FAIR; CONSOLIDER CPAN.

- **Experimental Molecular Physics (Staff: 22)**
  - Molecular Fluid Dynamics
  - Molecular Physics of Atmospheric & Astrophysical Systems
  - Laboratory Laser Spectroscopy for Remote Sensing
## Research Lines (2)

### Physics of Nanostructures & Biosystems (Staff: 17)
- Optical Spectroscopy on Plasmon Metal Nanostructures
- Chemical Physics of Photodeposition & Ablation Processes
- Biophysics
- CONSOLIDER on Cultural Heritage; CONSOLIDER EMET.

### Statistical Physics (Staff: 11)
- Systems Devoid of Long-Range Order
- Strongly Correlated & Mesoscopic Systems
- ISIS, ESS-Bilbao.

### Macromolecular Physics (Staff: 20)
- Nanostructure & Mechanical Properties of Polymer Systems
- Dynamics & Structure of Soft Condensed Matter
- Modeling & Properties of Synthetic & Biological Macromol. Systems
- ALBA, Repsol-YPF, Dow-Chemicals, Grupo Antolín.
**Plan 2005-2009: Funding**

**Funding (k€):**

- Period 2005-2007:
  - IEM\Astroph: 151 k€
  - Plan: 98 k€
  - Repsol-YPF, Dow-Chemicals, Grupo Antolín.

**Contracts:**

**Instituto de Estructura de la Materia**

**Impact Factor:**

![Graph showing impact factor from 2006 to 2007]

2006: Average 2.9
2007: Average 3.3

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Some Representative Journals (2005-2007) | Articles
--- | ---
Nature | 1
Phys. Rev. Lett. | 16
Phys. Rev. D | 16
Macromolecules | 6
Phys. Rev. C | 28
J. Chem. Phys. | 13
Phys. Rev. B | 31
J. Phys. Chem. A | 9
Polymer | 14
Nucl. Phys. A | 14

Instituto de Estructura de la Materia
IEM:

- 2442 ISI articles
- 37904 citations
- Average 15.52
- h=79
- 21 Tenured Scientists at IEM\Astroph with h≥15 (48%)
Plan 2005-2009: Training & Outreach

PhD Theses:

Courses (hours):

OUTREACH:

<table>
<thead>
<tr>
<th>Year</th>
<th>Plan</th>
<th>IEM\Astroph</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2006</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2007</td>
<td>7</td>
<td>5</td>
</tr>
</tbody>
</table>

+ 7 Associate Units with Universities

Outreach:

IE\M\Astroph 9 9 9

>50% conferences of Physics/CSIC in Madrid Science Week

Instituto de Estructura de la Materia
“Constraint damping in the Z4 formulation and harmonic gauge”.
C. Gundlach & J.M. Martín-García.
Class. Quantum Gravity 22, 3767 (2005), highlight. [22 citations]
Stabilization method employed in numerical simulations of black holes coalescence.

“Revised rates for the stellar triple-process from measurement of $^{12}\text{C}$ nuclear resonances”.
Implications for elemental abundances, and supernovae.

“Inelastic collisions in para-$\text{H}_2$: Translation-rotation state-to-state rate coefficients and cross sections at low temperature and energy”.
Non-reactive molecular collisions studied with highest detail. Relevant for astrophysics, validation of collision theory & intermolecular potentials.
“Strong enhancement of the radiative decay rate of emitters by single plasmonic nanoantennas”.
NANO LETTERS 7, 2871 (2007). [22 citations]
*Proof of the enhancement of spontaneous emission by nanoantennas.*

“Nature of the bound states of molecular hydrogen in carbon nanohorns”.
*Stable storage of hydrogen in nanohorns*.

“Evidence of early stage precursors of polymer crystals by dielectric spectroscopy”.
M. Soccio, A. Nogales, T.A. Ezquerra, et al.
*Structure development and dynamics are characterized by a single experiment during crystallization, supporting the existence of precursors.*
<table>
<thead>
<tr>
<th><strong>Strengths</strong></th>
<th><strong>Weaknesses</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interdisciplinarity</td>
<td>Recruiting students</td>
</tr>
<tr>
<td>Experimental &amp; theoretical</td>
<td>Postdocs</td>
</tr>
<tr>
<td>Scientific excellence</td>
<td>Workshop facilities</td>
</tr>
<tr>
<td>Unique laboratories</td>
<td>Lack of technicians</td>
</tr>
<tr>
<td>High visibility within CSIC</td>
<td>European grants</td>
</tr>
<tr>
<td>Seminal vocation</td>
<td>Lack of administrative staff</td>
</tr>
<tr>
<td>Large Facilities</td>
<td>Four buildings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Opportunities</strong></th>
<th><strong>Threats</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>ALBA, FAIR, ISIS, Herschel, ALMA</td>
<td>Bureaucratic burden</td>
</tr>
<tr>
<td>CONSOLIDER</td>
<td>Economical perspectives</td>
</tr>
<tr>
<td>Associate Units with University</td>
<td>Lines in boundary between fields</td>
</tr>
<tr>
<td>Outreach</td>
<td>Procedures for purchases</td>
</tr>
<tr>
<td>Multidisciplinary Networks</td>
<td>Difficulties for hiring (especially non-EU citizens)</td>
</tr>
<tr>
<td>Strategic Axes:</td>
<td>JAE system limits competition</td>
</tr>
<tr>
<td>&quot;Advanced Instrumentation &amp; Engineering&quot;, “Hydric Resources”, “Aging &amp; Life Quality”</td>
<td>Lost of human resources due to reallocations in other centres</td>
</tr>
</tbody>
</table>
Plan 2010-2013: General Goals

- Strengthen IEM as an international scientific reference centre.
- Consolidate the research lines, accomplishing scientific leaderships.
- Enforce the capability of the Institute in the training of scientific staff.
- Improve and update the existing laboratories.
- Enhance the visibility of IEM by intensifying the relations with other research groups and enterprises of international prestige.
- Promote the participation of the Institute in the different programs devoted to the dissemination of the scientific activity.
- Optimize the administrative procedures and increase the number of administration employees.
- Achieve stable positions for those postdoc researchers with proven scientific excellence.
- Establish cooperative interests with industrial partners.

Instituto de Estructura de la Materia
Strengthen the research on loop quantum gravity & cosmology. Develop the applications for cosmology (reduced models, inhomogeneities, inflation).

Continue work in computational gravity and numerical relativity. Apply computational techniques to loop quantum gravity/cosmology.

Analyze condensed matter analogues of gravity. Apply condensed matter methods to study the continuum limit of loop quantum gravity.

Study the structure & reactions involving exotic atomic nuclei:

- Theoretically
  - Medium & heavy nuclei: Mean-field calculations.
  - Light nuclei: Few-body techniques.

- Experimentally
  - Data analysis (5MeV tandem in UAM, two-proton radioactivity, beta decay, EM properties, halo nuclei)
  - Instrumentation (Gamma spectrometer CALIFA & Ge Gamma spectrometer DESPEC for FAIR, etc.)
Study of **molecules** of interest in **atmospheres & astrophysics**:

- Ices of frozen gases, molecules in astrophysical atmospheres (carbon chains, PAHs), radicals relevant for plasmas, atmospheric cloud aerosols, molecules on surfaces under strong laser radiation.

Study of the **gas dynamics at molecular scale**:

- State-to-state rate coeff. for inelastic rotational collisions at low T, structure, properties & kinetics of small H\textsubscript{2} & D\textsubscript{2} (& water) clusters, gas flow fields from controlled shape nozzles.

**Laser spectroscopy**

- Remote sensing (atmospheres, combustion).
- Validation of intermolecular potentials.

**Optical spectroscopies of molecules on metal nanostructures**:

- Surface-enhanced spectroscopy on new metal nanostructures.
- Theoretical investigation of these nanostructures. Nanosensors.
- Applications in Cultural Heritage & drug/biomolecule recognition.

Instituto de Estructura de la Materia
Spectroscopic studies of biological substances:
Applications to food quality & microspectroscopic biodiagnostics (Alzheimer). Development of spectroscopic accessories.

Spectroscopic study of physical chemistry processes at laser-induced ablation plumes & photodissociation plasmas.

Study of strongly correlated and mesoscopic systems:
Low-dimensional systems: Electronic properties of carbon materials, multi-component cold atom systems, combined effect of disorder & e-e interactions in transport properties. Interplay of integrability & chaos in static and dynamic quantum phase transitions in mesoscopic systems.

Study of systems devoids of long-range order:
Hydrogen adsorption on nanostructured carbon. Effect of confinement in condensed phases of the hydrogens. Artificial nanostructures of technological interest (e.g. crystalline aggregations of latex).
Advanced instrumentation for neutron scattering facilities:

Choppers, fast scintillation detectors, position sensitive detectors. H⁺ & H⁻ accelerator front-end for the **ESS-Bilbao**. Optimization of digital systems for data storage.


Experimental and computational study of solid formation & **structure-dynamics relationships in polymers**. Numerical codes & simulations to analyze folding processes of macromolecules.

Develop a line of analysis of macromolecular structures by **STEM**.

Study **confinement effects** in polymer systems, in particular in nanolayered and semicrystalline materials.
Plan 2010-2013: Outreach, Training...

- Upgrade the IEM “Introductory Course”.
- Encourage the participation in Master and Doctorate programs.
- Promote the creation of Master programs with “CSIC” label.
- Organize a yearly series of inter-dept. seminars for PhD students.

★ Maintain the commitment to the organization of the Science Week.
★ Participate in outreach initiatives with involvement of CSIC: ESTALMAT, Science in the City, IberCivis.
★ Improve the Institute web page.
★ Consolidate and strengthen the international collaborations.
★ Firmly support the participation at International Large Facilities.
★ Publicize abroad the position calls at all levels.
★ Stimulate the participation in European research grants.
★ Promote the organization of international congresses.
Plan 2010-2013: Strategy

- **Strengthen the research lines** (re-allocation of Astrophysics).
- **Recruitment of students:**
  - Associate Units, Adjunct Drs., Erasmus Placement Program.
- **Improve the administrative tools.** Create an intranet.
  - Increase of management staff, specially for international grants.
- **Update the scientific equipment.** Support workshop facilities.
- Reinforce the presence of IEM in **Strategic Axes:**
  - “Advanced Instrumentation and Engineering”,
  - “Hydric Resources” & “Aging and Quality of Life”.
- **Optimization of available space.**
- **Enhance outreach.** Request the creation of an Outreach Service.
- Strongly support the involvement in **International Large Facilities.**