

## Mapping the Structure and Evolution of Science

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### 1. Objective:

The current study focuses on the structure and the evolution of science in the global research areas based on bibliometrics. It will help to discover the hot research areas, select the priority areas, plan the development of discipline and optimize science policy.

### 2. Methods:

Data Collection: 1) Science Map (2004-2009): top 1% highly cited papers from ESI (2004.1-2010.5) as cited papers and all papers in SCI (2004-2009) as citing papers. 2) Science Map (2002-2007)1: ESI (2002.1-2008.4) as cited paper and SCI (2002-2007) as citing papers.

The method is reference to the studies on the science map of NISTEP.<sup>2</sup> 1) Research areas were identified by using "co-citation" clustering (single-link clustering) of research papers within two clusterings. The first clustering referred to Research Front and the second as Research Area. 2) Visualize research areas by Gravity Model mapping (force-directed method). Parallel mapping method<sup>3</sup> was taken improving Gravity Model to track changes in science map of the two periods. 3) Content analysis of hot research areas by experts. 4) Time-series analysis of Science Map (2002-2007), and Science Map (2004-2009) was preformed, including analysis of newly-derive, disappear, fuse, divide in all research areas<sup>4</sup>.

### 3. Results:

132 research areas were explored and "hot" research areas were identified. A map of science was generated to analyze the relationship between research areas. Based on the time-series analysis from science map (2002-2007) to science map (2004-2009), changes of research areas, migrations of knowledge, developments of the subject is explored. Compare the results with previous science map, 'particle physics and cosmology' is essentially unchanged, quantum gravity theory, modern cosmology, superstring theory, QCD phase transition and heavy ion collisions theory are continually "hot" areas; Group of research areas has changed dramatically In the 'Condensed matter physics'; Evolution of the 'nano technology' is covering some part of physics and medicine science, a new trend is the application of nano-materials in Biomedical; Earth

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<sup>1</sup> Pan, JF., Zhang, XL., Wang, XM., etc. 2010. Mapping Science Structure 2009. Science Press.

<sup>2</sup> NISTEP. 2009-02-02. Science map 2006 <http://www.nistep.go.jp/achiev/ftx/eng/rep110e/pdf/rep110e.pdf>.

<sup>3</sup> Igami, M., Saka, A. 2009. Observation of the evolution of science via the Science Map: methodology and application[J]. Journal of information processing and management, 52(8), 255-266.

<sup>4</sup> Han, T. 2008. Design and implementation of method for deep exploring the evolution of knowledge structure[D]. Beijing: National Science Library of CAS.

science is more prefer to study the corresponding of the common major issue; The clinical medicine has become fusion cross multiple fields, while the basic research has become more refinement and more division.

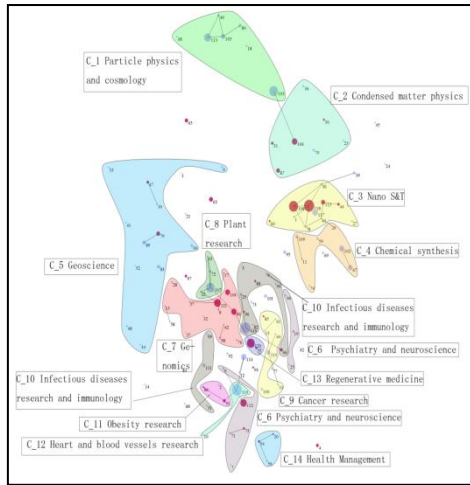


Figure 1 Science Map (2002-2007).

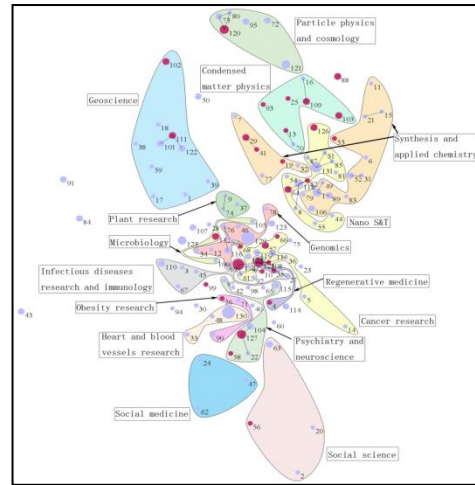


Figure 2 Science Map (2004-2009).

An example of Time-series analysis of science map as shown as in figure 3, the Carbon Nanotubes research area from previous science map (RA108) divides into Nanofibers research area (RA44) and Graphene research area (RA126) in the newer science map.

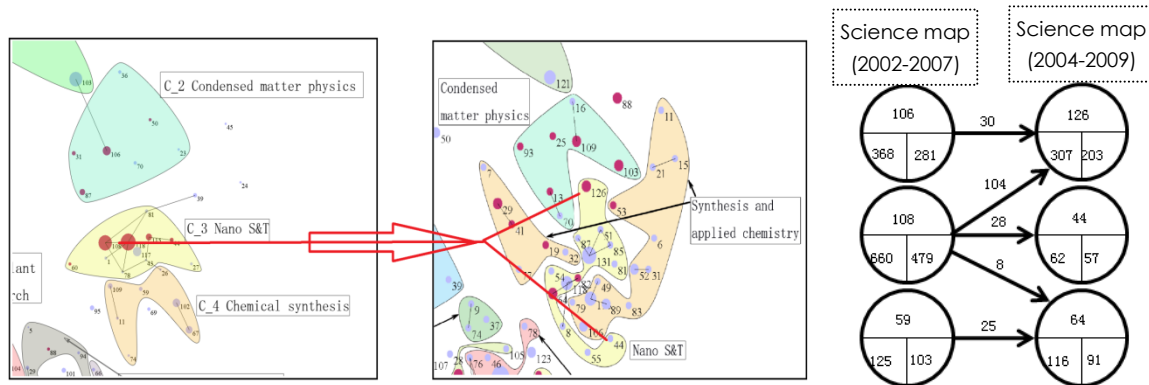


Figure 3 Evolution in Nano S&T.

#### 4. Conclusions

A possible approach was provided to discover and identify the emerging research areas, potential interdisciplinary and hot areas were detected by analysis of mapping and evolution of science. Further analysis could be done from a panoramic view of science, such as capture research activities, International cooperation of major country. With this context, it is hoped that policy making should be based on scientific evidence and grasp the exactly position of Chinese science and technology in the world.

**Keywords:** science map; science evolution; research area; co-citation