Combining scientometrics with patent-metrics for CTI service in R&D decision-makings

---- Practices and case study of National Science Library of CAS (NSLC)

By: Xiwen Liu

P. Jia, Y. Sun, H. Xu, S. Wang, L. Dong, X. Chen

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1. Introduce the NSLC

- ✓ Largest research library in China
- ✓ Central Library of NSL: Beijing
- ✓ Three branch libraries: Lanzhou, Chengdu, Wuhan
- ✓ About 110 institutional libraries
- ✓ Some professional(Subject) libraries

Founded in 1950
500+ librarians and staffs

Departments of NSLC

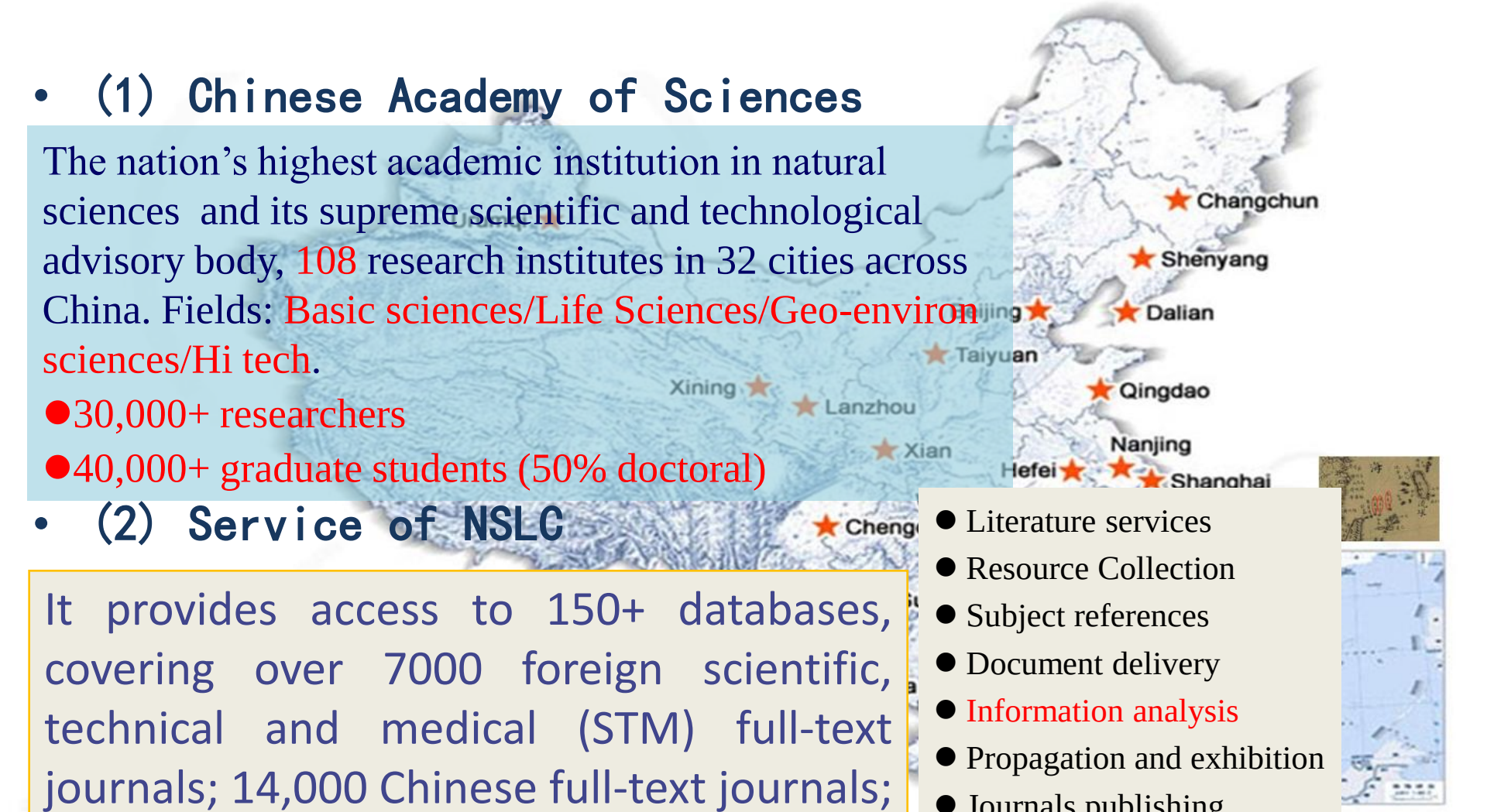
Resource Collection Dept.
Information service Dept.
Subject reference Dept.
Information analysis Dept.
IT system Dept.
Journals publishing Dept.
Propagation and exhibition Dept.
Degrees Program in LIS (PhD, MS)

2. Objects and Needs of Service

- (1) Chinese Academy of Sciences

The nation's highest academic institution in natural sciences and its supreme scientific and technological advisory body, 108 research institutes in 32 cities across China. Fields: Basic sciences/Life Sciences/Geo-environ sciences/Hi tech.

- 30,000+ researchers
- 40,000+ graduate students (50% doctoral)



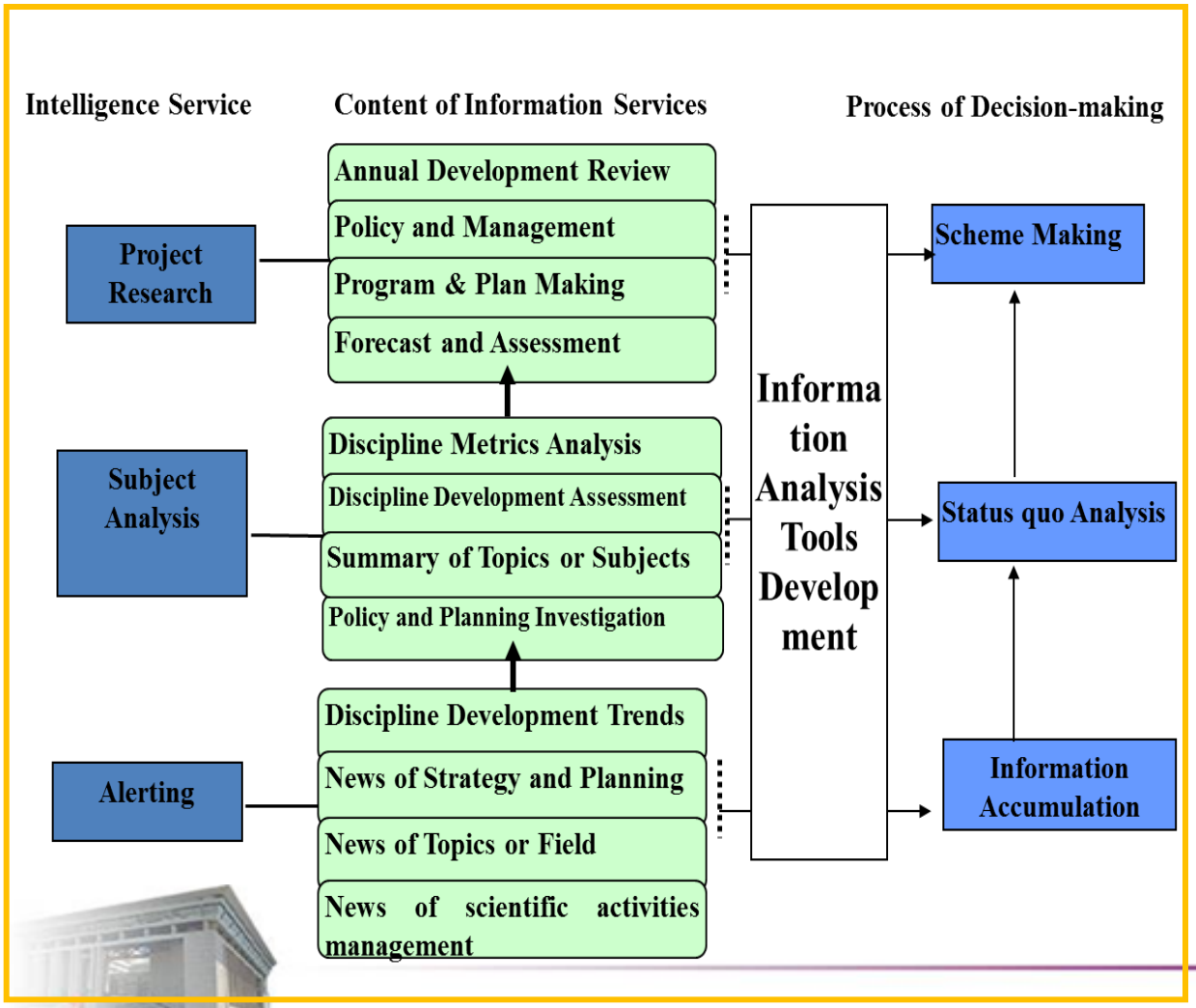
- (2) Service of NSLC

It provides access to 150+ databases, covering over 7000 foreign scientific, technical and medical (STM) full-text journals; 14,000 Chinese full-text journals; 415,000 foreign theses and dissertations.

- Literature services
- Resource Collection
- Subject references
- Document delivery
- Information analysis
- Propagation and exhibition
- Journals publishing
- Education

3. Information analysis and service of NSLC

– Alerting; Subject fields analysis; Consulting and projects



General:

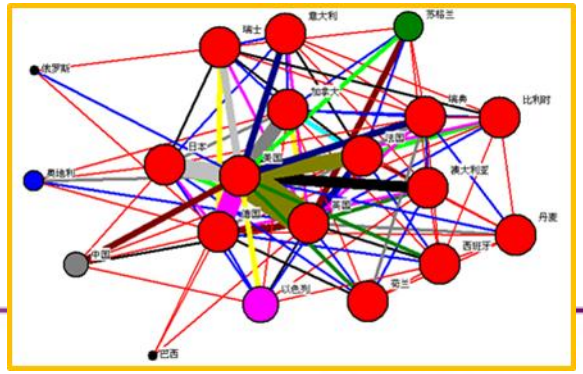
Intl R&D Strategies & Policies
Intl R&D Comp & Collab & Evaluation
……

Field or Problem-based:

R&D Trends Analysis
R&D Comp & Collab & Evaluation
……

Industrial technology:

R&D development service
Sector technology analysis
…...



- Several kinds of reports:
  - S&T dynamic monitoring reports
  - S&T (or technical area) subject analysis and scanning
  - analysis reports for S&T trend
  - strategy and planning consulting report of S&T.

scientometric indicators were be applied into the decision-making support and scientific subject monitoring.

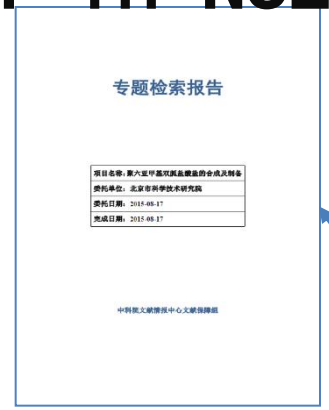
- In the reports: we should have combined the different methods like bibliometrics, patents-metrics, text-mining, and experts review together, for improving the quality of reports.

Service Cases of CTI in NSLC

novelty review for the development

CTI for technology theme

CTI for an industry or sector



micro level

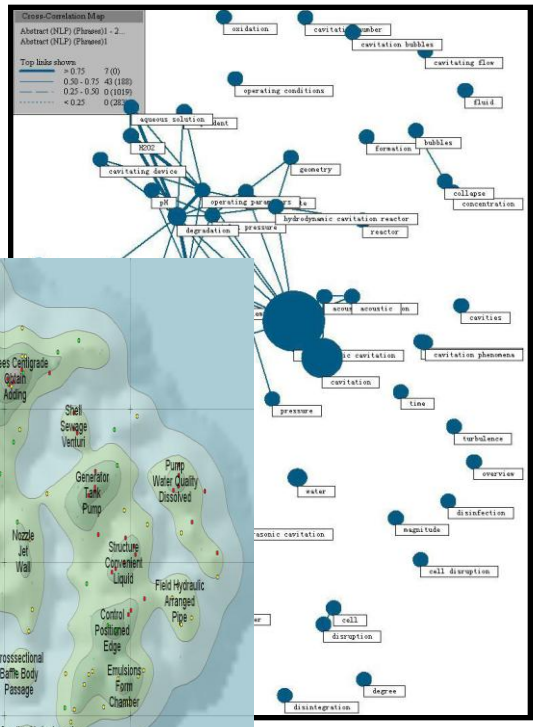
meso level

macro level

4. Examples of NSLC in CTI

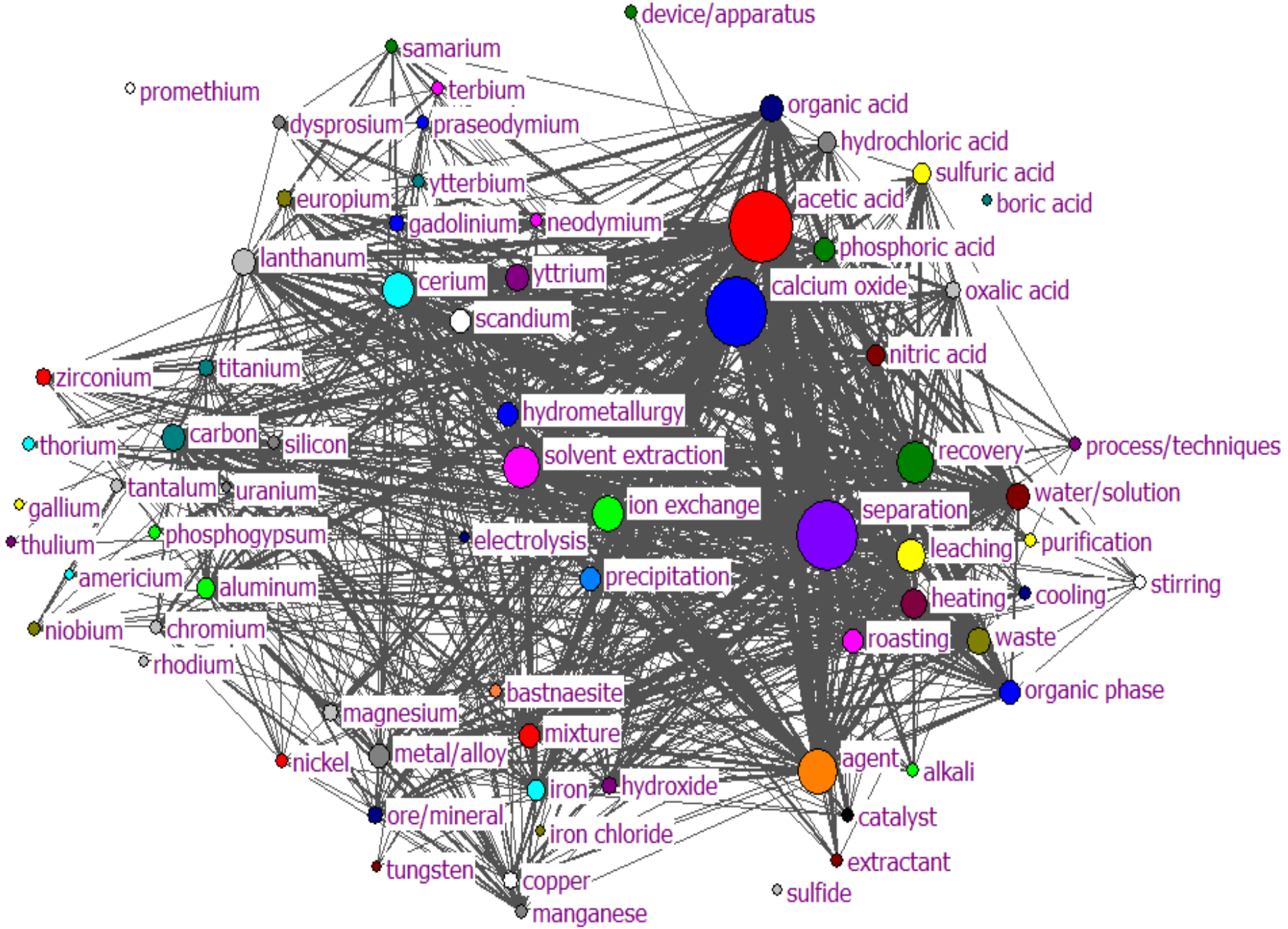
- 4.1 Novelty checkup service for Development of a Specific Technology Topic
  - evaluating the novelty and necessity of a R&D project proposal
  - assessing a finished project's performance and achievements

- **Novelty review report: Hydrodynamic cavitation technology for the wastewater processing**
- Methodology
  - 1. to search relevant scientific papers and form a research article dataset
  - 2. keywords from those research articles, clustering , then drawing the domains networks
  - 3. searching patent data of hydrodynamic cavitation innovation and applications-patent theme map
  - 4. to identify the emergency tech point



- **4.2 Competitive technical intelligence for the technology subjects**
  - To comprise the full range analysis of the related technology topic, and to integrate the scientometric index, patent technology analysis and professional reviews of technological development
  - **Technology Intelligence report:** A medical technology company of the vaccines for pig;
  - To analyze the R&D advancement in this subfield with the help of bibliometric indicators like article publications and citation data
  - Methodology
    - Searching the databases of ISI Web of Science and ISI Medline
    - Creating a patent dataset by ISI Derwent Innovations Index
    - Indicating the most popular research subjects
    - Identifying the primary patent topics

- **4.3 CTI for the industrial sector---macro level service of NSLC**
  - To combine different analysis methods and tools, such as the literature review (tertiary information or document), scientometric indicators, patent analysis, and text-mining, together to make our report
  - To construct the key intelligence topics (KIT) according to our discussions with the researchers
  - To perform the bibliometric analysis and patent technology theme (or core-tech) analysis
- **CTI for Ionic Rare Earth Industry**
  - Methodology
  - To identify and review the key technology fields or topics
  - To analysis for each of these fields and topic
    - Research organization analysis
    - Cluster analysis of subfields of the current research areas


device/apparatus
samarium
promethium
terbium
organic acid
dysprosium
praseodymium
hydrochloric acid
sulfuric acid
ytterbium
europium
acetic acid
boric acid
gadolinium
neodymium
phosphoric acid
lanthanum
cerium
yttrium
calcium oxide
oxalic acid
scandium
nitric acid
zirconium
titanium
hydrometallurgy
carbon
thorium
silicon
solvent extraction
recovery
process/techniques
tantalum
uranium
water/solution
gallium
ion exchange
separation
thulium
phosphogypsum
electrolysis
leaching
purification
americium
precipitation
stirring
aluminum
heating
cooling
niobium
chromium
roasting
waste
rhodium
bastnaesite
organic phase
magnesium
mixture
metal/alloy
agent
nickel
alkali
iron
hydroxide
ore/mineral
catalyst
iron chloride
extractant
tungsten
copper
sulfide
manganese

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5. Experiences and Realizations

- 5.1 To defines the service objectives and clients as R&D management, research teams, research projects, technological innovation of firms, and industrial technology development

- 5.2 To classify the CTI services into three levels, and to create the quite different tactics for the application of scientometric indicators accordingly
  - **At micro level:** The services for assessing advancement and feasibility of the technology, and identifying the key competitors, and so forth.---novelty review for R&D project proposal and evaluation of advancement of product technology
  - Methodology
  - To precisely retrieve and collect the information and form a dataset
  - To read the research paper and patent applications one by one
  - To figure out the important research themes, direction, research communities (teams and individuals), collaboration, and competitive relationship or situations by clustering
  - To summarize and induce from the comprehensive review of scientific advancements (tertiary information)

- **At meso level: CTI for the technology**
- Methodology
- to establish a framework for technology topic analysis firstly by discussing with the customers
- To collect the scientific research and patent applications information by repeatedly iteration and then form a database
- To choose the indicators of bibliometrics or scientometrics and patent-metrics to analyze the stages of technology development
  - to find the important research institutions (important research teams and researchers)
  - to highlight the hottest technology subjects or topics
  - to reveal the relationship of keywords
- To identify the development stages, key and important specialists, core technology, and relationships between research themes

- **At macro level: CTI for industries**
- Methodology
- Methods of scientometrics and text-analysis and text-mining based on the big data should be used comprehensively
- To search the features of the technology evolution, that of hot technology topics, relevance of technology topics, the relationship of technology with industries and technology competitive landscape
- To figure out different relationships via analyzing the metadata of academic articles, patents and mining the information and words relationship from the full text

序号	机构	国家	数量
1	CHINESE ACADEMY OF SCIENCES	中国	15
2	NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE TECHNOLOGY AIST	日本	11
3	RUSSIAN ACADEMY OF SCIENCES	俄罗斯	11
4	JIANGXI ACAD SCI	中国	8
5	CENTRAL SOUTH UNIVERSITY	中国	6
6	NATIONAL ACADEMY OF SCIENCES UKRAINE	乌克兰	6
7	UNITED STATES DEPARTMENT OF ENERGY DOE		
8	WUHAN INSTITUTE OF TECHNOLOGY		
9	COUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH CSIR INDIA		
10	PEKING UNIVERSITY		
11	TOHOKU UNIVERSITY		
12	TSING HUA UNIVERSITY		

表 22 离子稀土研究的核心机构

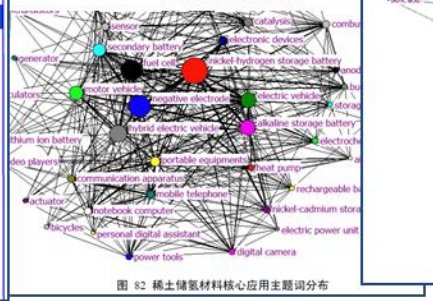


图 82 稀土储氢材料核心应用主题词分布

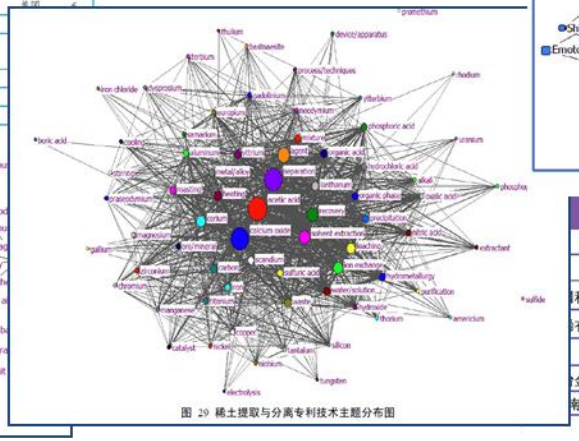


图 29 稀土提取与分离专利技术主题分布图

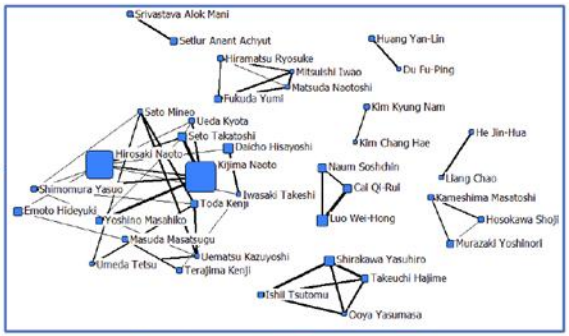


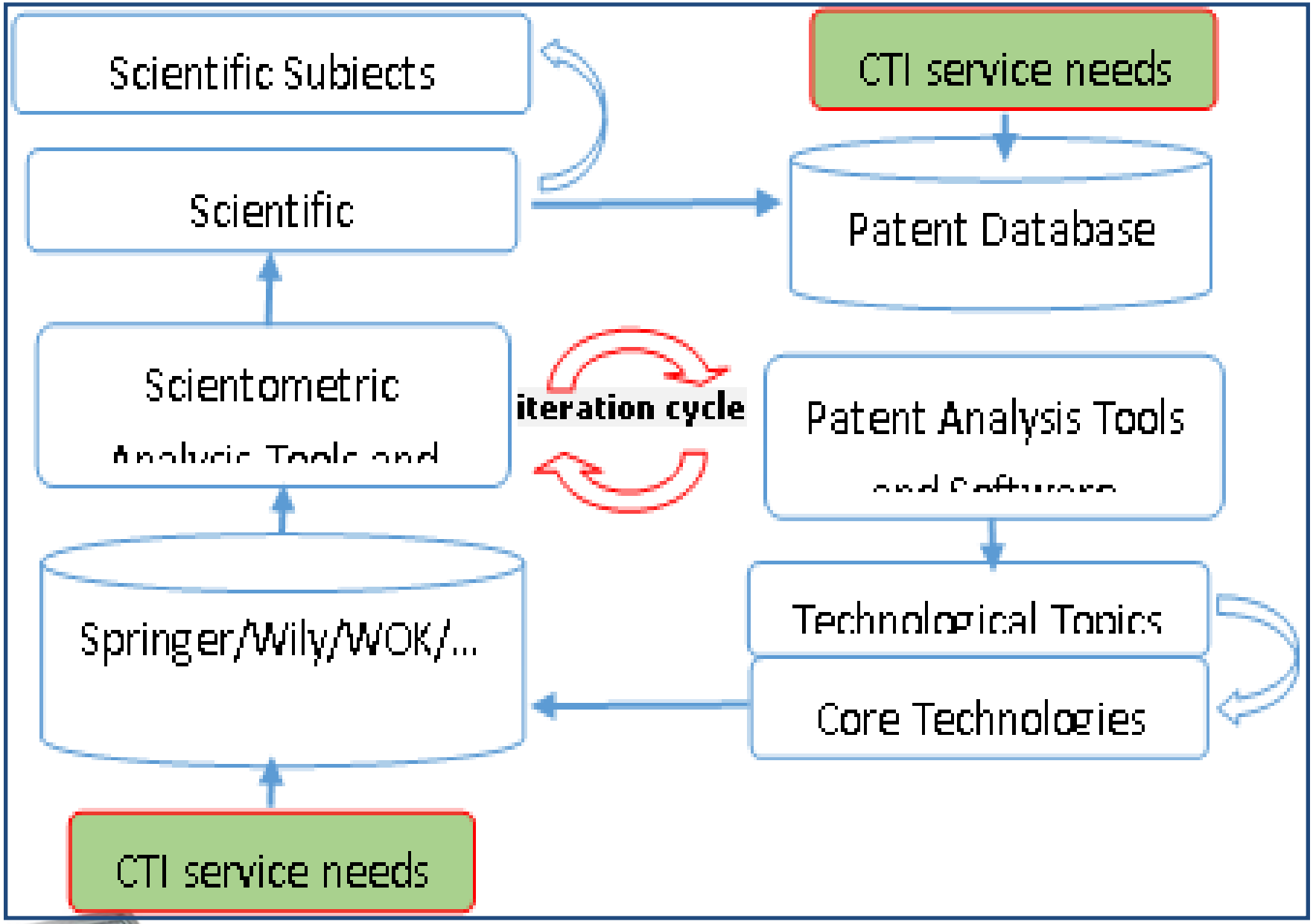
图 68 白光 LED 荧光粉领域 TOP50 发明人合作网络

	活动年期	发明人数	平均专利年龄
赣州有色冶金研究所	7	6	29	23.0
江西理工大学	5	2	24	1.1
科学院长春应用化学研究所	5	3	12	22.3
有金属钨业控股集团有限公司	4	2	2	3.3
武汉工程大学	3	2	9	2.5
金工业部包头稀土研究院	3	2	5	21.8
南方稀土高技术股份有限公司	3	1	9	13.0

表 24 离子稀土提取核心专利权人

- 5.3 Analyzing the technology trends of an industry via the combination of bibliometric and patent-metric indicators
  - bibliometrics or scientometrics, which are based on academic articles, mainly rely on metadata of the articles to reflect the scientific research activities
    - The amount of publications could reflex the vitalities of the research field
    - The amount of citations could refract the importance of the article
    - The publications could show the research abilities of the countries, regions, and organizations that produce them
  - metadata analysis based on patents could imply the relationship between scientific researches and industry
    - To show the technology innovation capability of firms (research institutes, countries, and regions), partnership and competition between them, and the evolution or inheritance relationship of technology
    - To use patent citation and to identify the core technology in an industry, form the patent pool, and develop the cooperation in R&D
  - CTI services need to construct an integrated and complex analysis framework, regarding both academic articles and patents to show the R&D situation of an entire industry

- 5.4 Establishing the “iteration” CTI analysis mode for science and technology monitoring
  - CTI services are mainly consisted by two parts, the monitoring of research subject and that of technology development
  - To establish an iteration mode----“bibliometric analysis + patent technology analysis”.
    - Scientific subject framework will be constructed by bibliometric analysis at first
    - The key industrial technology will be chosen as topics from the bibliometric subject framework
    - The core patent technology will be picked out from the patent-metrics
    - The content analysis and mining will also be introduced in this process
  - For consulting agencies (such as the NSL-CAS) suffer problem of lacking specific professional who have the detailed scientific and technological knowledge or subject background


Scientific Subjects
CTI service needs
Scientific
Patent Database
Scientometric
iteration cycle
Patent Analysis Tools
Springer/Wily/WOK/...
Technological Topics
Core Technologies
CTI service needs

- 5.5 Creating the CTI service procedures, ensuring the involvement of the professionals and their consulting

  - To guarantee the reliability of our analysis reports, NSL-CAS has quality control measures and principles in the analysis processes
  - CTI services for the technology subjects:
    - To set up the procedure for the service applications, to keep communicating with researchers. To get some key words or subject words for searching for the articles or patents
    - To exchange ideas with researchers and clients, improve and optimize the preliminary searching results, and form the database of the full text article and abstracts or patent application
    - To do the scientific keywords-based clustering analysis, to construct a research subject or technology topic framework
    - To setup the new kind service model, operating the CTI based on the key intelligence topics (KIT), and let the KIT be the core of technology subject analysis

- 5.6 Integrating sources of business information and technology intelligence, and to provide the customized services according to the needs
  - To associate the trends of technology development, competitiveness of technology intelligence, industrial technology development, and business intelligence together, and to provide differentiated CTI services to meet different decision-making needs.
  - To choose or construct (customize) different indicators schema for different analysis purposes.
    - For the industrial technological strategy support and technology innovation path identification (or selection), the scientometirc indicators could play the right roles of technology development as soon as possible.
    - In the meso-technology-analysis, bibliometrics and patent analysis indicators should be mixed in accordance of different subjects or stages of the emerging technology whose characteristics could then be indicated by these mixed indicators.
    - In a micro-technology-analysis, as patent technology analysis and core technology are mainly for the new product development, thus some bibliometric indicators that indicate the technology tendency should also be added.

6. Summary

- **A fine CTI report should include the technology topics, selection of technology innovation pathway, future technology directions, market and business intelligence, competitors' intelligence and production intelligence.**

- **In the CTI reports, the bibliometric indicators, patent metrics indicators (including the text-mining for themes or subjects), even the local investigations of competitors, should be included.**

- **Thanks for your attentions.**
- **Any questions?**