

时频技术及氢钟设备领域动态

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本期概要：

本期动态专题扫描了 2014 年以来氢钟技术方向的论文发表情况，并检索了 PTTI\IEEE 等国际会议在星载氢钟、地面氢钟、光钟、冷原子钟、汞钟等技术发表的论文情况。

【研究动态：氢原子钟相关技术】

本期动态专题扫描了氢钟、光钟、冷原子钟、汞钟等设备及时频技术高精度方面最新研究动态。

◇ 氢钟

在 WOS 数据库中检索到, 2014 年以来, 在氢钟技术方面有 16 篇最新的研究论文:

1	Yang, Cheng , Progress and performance evaluation of BeiDou global navigation satellite system: Data analysis based on BDS-3 demonstration system ,SCIENCE CHINA-EARTH SCIENCE,S v.61 is5 p614 -624, 2018
2	张涛; 谷守周; 秘金钟; 李超; 盛传贞, 不同基准钟约束的卫星钟差精度分析 , 导航定位学报, 第六卷, 第一期, 10-14 页, 2018
3	朱江淼; 孙盼盼; 高原; 秦慧军, 原子钟频差数据去噪算法的研究 , 计量学报, 第 38 卷, 第四期 499-503 页, 2017
4	艾青松; 徐天河; 贾小林; 孙大伟, 精密定轨与时间同步系统噪声对 GNSS 卫星钟性能评估的影响分析 , 大地测量与地球动力学, 第 37 卷, 第 9 期, 937-941 页, 2017
5	裴鑫; 李健; 袁建平; 温志刚; 陈卯蒸, 基于 ROACH2 的脉冲星终端研制进展 , 天文学进展, 2017
6	李变; 屈俐俐, 基于 EMD 的氢钟频率预报方法研究 , 宇航计测技术, 第 36 卷, 第 3 期 50-53 页, 2016
7	王玲玲, VLBI 测站时频自动切换系统的设计和实现 , 天文研究与技术, 第 12 卷, 第 2 期, 166-173 页, 2015
8	王文明, 双真空结构设计对氢原子钟温度灵敏度的改善研究 , 真空科学与技术学报, 第 34 卷, 第 5 期, 500-503 页, 2014
9	Wang, Xianglei; Du, Yan; Zhang, Jun , Performance Test and Power-Law Spectrum Analysis of Domestic Cesium Clocks ,CHINA SATELLITE NAVIGATION CONFERENCE (CSNC) 2017 PROCEEDINGS, VOL III v.439 p547-552, 2017

10	Chen, Haijun; Liang, Youhuan; Yang, Jianqing; Liu, Zhongzheng; Feng, Jinjun; Zhang, Xiaogang; Zhang, Shengnan; Chen, Jingbiao, Study of a fully vacuum-sealed calcium atomic beam tube for optical frequency standard , 2016 IEEE International Frequency Control Symposium (IFCS), 2016
11	Liang Kun; Zhang Aimin; Wang Weibo; Ning Dayu; Gao Yuan; Yang Zhiqiang; Zhao Kejia; Zhang Yue; Liu Kun; Long Bo New Timekeeping System and its Time Link Calibration at NIM , 2014 IEEE INTERNATIONAL FREQUENCY CONTROL SYMPOSIUM (FCS) p202-205, 2014
12	Zhang Aimin; Wang Weibo; Gao Yuan; Liang Kun; Yang Zhiqiang; Liu Kun, Research on Modification of H-maser Drift , 2014 IEEE INTERNATIONAL FREQUENCY CONTROL SYMPOSIUM (FCS) p398-400, 2014
13	ZHU J; CHEN Y; YAN D; ZHANG Y, Genetic algorithm based cesium fountain clock and hydrogen clock frequency difference estimation method, involves eliminating outlier value to obtain cesium atomic fountain clock and hydrogen clock frequency difference data
14	GONG H; LIU Z; OU G; LIU W; WANG Y; SUN G; WU W; WU Y; ZHU X Kalman filter plus delay device atom clock digital lock phase loop driving method, involves adjusting noise variance according to fixation process, generating phase noise curve of caesium clock, and determining kalman gain value
15	GONG H; HUANG X; OU G; LIU W; HUANG Y; LI Y; WU Y; ZHU X, Second-state variable Kalman filter clock driving method, involves driving cesium clock and deviation hydrogen clock, and performing Kalman filter clock driving process to obtain optimal parameter
16	SONG W; ZHU J, Hydrogen atom clock forecasting method, involves connecting input unit and output unit with hidden layer unit, and calculating threshold value of output unit with reference of minimum hydrogen clock value

◇ 光钟

在 WOS 数据库中检索到, 2018 年以来, 在光钟技术方面有 18 篇最新的研究论文

1	Kudeyarov, K. S.; Vishnyakova, G. A.; Khabarova, K. Yu; Kolachevsky, N. N. 2.8 km fiber link with phase noise compensation for transportable Yb+ optical clock characterization , LASER PHYSICS, v28, i10, 2018
2	Pan, Duo; Shi, Tiantian; Chen, Jingbiao, Dual-wavelength good-bad cavity laser system for cavity stabilized active optical clock , IEEE transactions on ultrasonics, ferroelectrics, and frequency control, 2018
3	Fu, Xiaohu; Fang, Su; Zhao, Ruchen; Zhang, Ye; Huang, Junchao; Sun, Jianfang; Xu, Zhen; Wang, Yuzhu, Observation of the S-1(0)-P-3(0) optical clock transition in cold Hg-199 atoms , CHINESE OPTICS LETTERS, v16, i6, 2018
4	Zeng, Meng-Yan; Huang, Yao; Shao, Hu; Wang, Miao; Zhang, Hua-Qing; Zhang, Bao-Lin; Guan, Hua; Gao, Ke-Lin, Improvement of Stability of Ca-40(+) Optical Clock with State Preparation , CHINESE PHYSICS LETTERS, v35, i7, 2018
5	Gao, Qi; Zhou, Min; Han, Chengyin; Li, Shangyan; Zhang, Shuang; Yao, Yuan; Li, Bo; Qiao, Hao; Ai, Di; Lou, Ge; Zhang, Mengya; Jiang, Yanyi; Bi, Zhiyi; Ma, Longsheng; Xu, Xinye, Systematic evaluation of a Yb-171 optical clock by synchronous comparison between two lattice systems , SCIENTIFIC REPORTS, v8, 2018
6	Ludlow, Andrew D, An optical clock to go , NATURE PHYSICS, v14, i5, p431-432
7	Grotti, Jacopo; Koller, Silvio; Vogt, Stefan; Haefner, Sebastian; Sterr, Uwe; Lisdat, Christian; Denker, Heiner; Voigt, Christian; Timmen, Ludger; Rolland, Antoine; Baynes, Fred N.; Margolis, Helen S.; Zampaolo, Michel; Thoumany, Pierre; Pizzocaro, Marco; Rauf, Benjamin; Bregolin, Filippo; Tampellini, Anna; Barbieri, Piero; Zucco, Massimo; Costanzo, Giovanni A.; Clivati, Cecilia; Levi, Filippo; Calonico, Davide, Geodesy and metrology with a transportable optical clock , NATURE PHYSICS, v14, i5, p437, 2018
8	Shi, Tiantian; Pan, Duo; Chang, Pengyuan; Shang, Haosen; Chen, Jingbiao, A highly integrated single-mode 1064 nm laser with 8.5 kHz linewidth for dual-wavelength active optical clock , REVIEW OF SCIENTIFIC INSTRUMENTS, v89, i4, 2018
9	Blau, Steven K. A PORTABLE OPTICAL CLOCK, PHYSICS TODAY, v71, p23-23, 2018

10	Hachisu, Hidekazu; Nakagawa, Fumimaru; Hanado, Yuko; Ido, Tetsuya, Months-long real-time generation of a time scale based on an optical clock , SCIENTIFIC REPORTS, v8, 2018
11	Zhao Fang-Jing; Gao Feng; Han Jian-Xin; Zhou Chi-Hua; Meng Jun-Wei; Wang Ye-Bing; Guo Yang; Zhang Shou-Gang; Chang Hong, Miniaturization of physics system in Sr optical clock , ACTA PHYSICA SINICA, v67, i5, 2018
12	Phelps, Gretchen; Lemke, Nathan; Erickson, Christopher; Burke, John; Martin, Kyle, Compact Optical Clock with 5×10^{-13} Instability at 1 s , NAVIGATION-JOURNAL OF THE INSTITUTE OF NAVIGATION, v65, i1, p49-54, 2018
13	Xu Qinfang; Yin Mojuan; Kong Dehuan; Wang Yebing; Lu Benquan; Guo Yang; Chang Hong, Optical frequency comb active filtering and amplification for second cooling laser of strontium optical clock , Acta Physica Sinica, v67, i8, 2018
14	Baynham, Charles F. A.; Godun, Rachel M.; Jones, Jonathan M.; King, Steven A.; Nisbet-Jones, Peter B. R.; Baynes, Fred; Rolland, Antoine; Baird, Patrick E. G.; Bongs, Kai; PatrickGill; Margolis, Helen S., Absolute frequency measurement of the S-2(1/2) -> F-2(7/2) optical clock transition in Yb-171(+) with an uncertainty of 4×10^{-16} using a frequency link to international atomic time , JOURNAL OF MODERN OPTICS, v65, p585-591, 2018
15	Yao, Jian; Sherman, Jeffrey; Fortier, Tara; Parker, Thomas; Levine, Judah; Savory, Joshua; Romisch, Stefania; McGrew, William; Zhang, Xiaogang; Nicolodi, Daniele; Fasano, Robert; Schaeffer, Stephan; Beloy, Kyle; Ludlow, Andrew, Incorporating an Optical Clock into a Time Scale at NIST: Simulations and Preliminary Real-Data Analysis , PROCEEDINGS OF THE 49TH ANNUAL PRECISE TIME AND TIME INTERVAL SYSTEMS AND APPLICATIONS MEETING, p11-21, 2018
16	Baynham, Charles F. A. Absolute frequency measurement of the S-2(1/2) -> F-2(7/2) optical clock transition in Yb-171+ with an uncertainty of 4×10^{-16} using a frequency link to international atomic tim (vol 65, pg 585, 2018) , JOURNAL OF MODERN OPTICS, v65, i4, p480-480, 2018
17	Yao, Jian; Parker, Thomas E.; Ashby, Neil; Levine, Judah, Incorporating an Optical Clock Into a Time Scale , IEEE TRANSACTIONS ON ULTRASONICS FERROELECTRICS AND FREQUENCY CONTROL, v65, i1, p127-134, 2018
18	Kudeyarov, K. S.; Vishnyakova, G. A.; Khabarova, K. Yu; Kolachevsky, N. N., 2.8 km fiber link with phase noise compensation for transportable Yb+ optical clock characterization , LASER PHYSICS, v28, i10, 2018

◇ 冷原子钟

在 WOS 数据库中检索到，近五年，在冷原子钟技术方面有 6 篇最新的研究论文，3 项专利

1	LIU Q; WANG B; XIANG J, Laser cooled atomic clock optical cross-state selecting device for core device, has square body cut along midline of each side to remove eight vertex angles, and original square whose six sides are provided with window and cooling component , 专利号: CN108333909-A, 专利权人和代码: CAS SHANGHAI INST OPTICS & FINE MECHANIC
2	Yu, Jiachen; Wang, Pingjun; Yu, Qi; Zhang, Yin; Xiong, Wei; Chen, Xuzong, Stabilized DFB laser system with large tuning range , CHINESE OPTICS LETTERS, v16, i3, 2018
3	Liang, Shang-qing; Xu, Yun-fei; Lin, Qiang, Laser frequency locking with low pump field saturated absorption spectroscopy , JOURNAL OF ZHEJIANG UNIVERSITY-SCIENCE A, v19, i2, p171-174
4	Ascarrunz, F. G.; Dudin, Y. O.; Aramburo, Maria. C. Delgado; Savory, J.; Jefferts, S. R., Long-term frequency instability of a portable cold 87Rb atomic clock , PROCEEDINGS OF THE 49TH ANNUAL PRECISE TIME AND TIME INTERVAL SYSTEMS AND APPLICATIONS MEETING, p107-110, 2018
5	刘春保, 国外空间原子钟发展研究 , 航天器工程, 第 27 卷, 第 1 期, 123-129 页, 2018
6	项静峰; 王利国; 李琳; 吕德胜; 刘亮, 基于 DSP 技术的外腔半导体激光器自动稳频系统 , 光学学报, 第 37 卷, 第 9 期, 2017 年
7	ZHENG G, Gravity-based frequency shift timing device, has local receiver connected with remote receiver, receiving unit connected with Beidou satellite system through by gravity gradiometer, and processing device connected with satellite system , 专利号: CN205620685-U, 专利权人和代码: UNIV JIANGHAN
8	CAI H; CHEN D; YING K; GONG S; NIU Y; DI R; QU R, Frequency stabilizing method of center frequency tuning semiconductor laser, used in e.g. laser atom cooling field, involves connecting semiconductor laser controller to output end of phase lock amplifier , 专利号: CN104767119-A CN104767119-B, 专利权人和代码: CAS SHANGHAI INST OPTICS & FINE MECHANIC
9	屈求智; 夏文兵; 汪斌; 吕德胜; 赵剑波; 叶美凤; 任伟; 项静峰; 刘亮, 空间激光冷却原子集成光学平台设计 , 光学学报, 第 35 卷, 第 6 期, 2015 年

◇ 汞钟

在 WOS 数据库中检索到, 近五年, 在汞钟技术方面有 1 篇最新的研究论文

1	Guo, C.; Favier, M.; Calvert, J.; Cambier, V; Galland, N.; De Sarlo, L.; Bize, S., A Mercury Optical Lattice Clock with Improved Magic Wavelength Control , 2017 JOINT CONFERENCE OF THE EUROPEAN FREQUENCY AND TIME FORUM AND IEEE INTERNATIONAL FREQUENCY CONTROL SYMPOSIUM (EFTF/IFC), p498-499, 2017
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【 The Precise Time and Time Interval Systems and Applications (PTTI) meeting 会议论文扫描】

◇ 光钟技术

1. Sherman, Jeffrey, Fortier, Tara, Yao, Jian, Parker, Thomas, Levine, Judah, Savory, Joshua, Romisch, Stefania, McGrew, William, Zhang, Xiaogang, Nicolodi, Daniele, Fasano, Robert, Schaeffer, Stephan, Beloy, Kyle, Ludlow, Andrew, **"Incorporating an Optical Clock into a Time Scale at NIST: Simulations and Preliminary Real-Data Analysis,"** Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 11-21.
<https://www.ion.org/publications/abstract.cfm?articleID=15624>

◇ 原子钟技术

1. Chen, Po-Ting, Speyer, Jason L., Majid, Walid A., **"Frequency Stability Analysis of Pulsar Aided Atomic Clocks,"** Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 30-44.
<https://www.ion.org/publications/abstract.cfm?articleID=15604>
2. Gutt, Gregory, Lawrence, David, Cobb, Stewart, O'Connor, Michael, **"Recent PNT Improvements and Test Results Based on Low Earth Orbit Satellites,"** Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 72-79.
<https://www.ion.org/publications/abstract.cfm?articleID=15606>
3. Warren, Zachary, Huang, Michael, Kettering, Hunter, Stapleton, Andrew, Camparo, James, **"A Versatile Testbed for CubeSat Atomic Clock Development: EOM vs Laser Current Modulation,"** Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 100-106.

<https://www.ion.org/publications/abstract.cfm?articleID=15610>

4. Ascarrunz, F. G., Dudin, Y. O., Aramburo, Maria. C. Delgado, Savory, J., Jefferts, S.R., **"Long-Term Frequency Instability of a Portable Cold 87Rb Atomic Clock,"** Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 107-110.
<https://www.ion.org/publications/abstract.cfm?articleID=15599>
5. Dowd, Andrew V., **"Improved Temperature Compensation of Atomic Clocks and INS Instruments using Multivariate Model-based Design Optimized for Real-world Operating Conditions.,"** Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 111-124.
<https://www.ion.org/publications/abstract.cfm?articleID=15601>
6. Wu, Wenjun, Guang, Wei, Bauch, Andreas, Dong, Shaowu, Qin, Weijin, Zhang, Jihai, **"BeiDou Time Transfer Between PTB and NTSC,"** Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 173-183.
<https://www.ion.org/publications/abstract.cfm?articleID=15616>
7. Jing, Wen-fang, Xu, Li-ye, Lu, Xiao-chun, Zhang, Rui, **"Carrier Phase Timing with Single Satellite Based on an Open Testing Platform,"** Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 209-213.
<https://www.ion.org/publications/abstract.cfm?articleID=15618>
8. Charbonneau, André, Douglas, Rob, Gertsvolf, Marina, **"Traceable Time Dissemination with NTP,"** Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 237-243.
<https://www.ion.org/publications/abstract.cfm?articleID=15621>

◇ 离子钟技术

1. Scherer, David R., Boschen, C. Daniel, Noble, Jay, Silveira, Michael, Taylor, Dwayne, Tallant, Jonathan, Overstreet, K. Richard, Stein, S. R., **"Analysis of Short-Term Stability of Miniature 171Yb+ Buffer Gas Cooled Trapped Ion Clock,"** Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 95-99.
<https://www.ion.org/publications/abstract.cfm?articleID=15609>

✧ 氢钟技术

1. Guo, Yichen, Wang, Bo, Dong, Jingwen, Si, Hongwei, Wang, Lijun, "**Correlation Measurement of Co-Located Hydrogen Masers Using Fiber-Based Frequency Synchronization Network**," Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 138-142.
<https://www.ion.org/publications/abstract.cfm?articleID=15612>

✧ 其他时频技术

1. Lin, Shinn-Yan, Jiang, Zhiheng, "**The Long Term Stability and Redundancy Test of GPS Multi-Receiver Ensemble**," Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 154-163.
<https://www.ion.org/publications/abstract.cfm?articleID=15614>
2. Liang, K., Arias, F., Jiang, Z., Petit, G., Tisserand, L., Wang, Y., Uhrich, P., Rovera, G.D., Koshelyaevsky, N., Lin, C., Powers, E.D., Mitchell, S., Yang, Z., Zhang, A., Fang, Z., "**Evaluation of BDS Time Transfer on Multiple Baselines for UTC**," Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 164-172.
<https://www.ion.org/publications/abstract.cfm?articleID=15615>
3. Novick, Andrew N., Lombardi, Michael A., Franzen, Kevin, Clark, John, "**Improving Packet Synchronization in an NTP Server**," Proceedings of the 49th Annual Precise Time and Time Interval Systems and Applications Meeting, Reston, Virginia, January 2018, pp. 256-260.
<https://www.ion.org/publications/abstract.cfm?articleID=15623>

【 IEEE International Frequency Control Symposium 会议论文扫描 】

✧ 氢钟技术

1. **Kalman timescale algorithm based on hydrogen clock ensemble.** Jiangmiao, Zhu Di, Yan; Yuhui, Qin; Ye, Chen; Wenjuan, Wu Source: ICEMI 2017 - Proceedings of IEEE 13th International Conference on Electronic Measurement and Instruments, v 2018-January, p 591-596, January 19, 2018, ICEMI 2017 - Proceedings of IEEE 13th International Conference on Electronic Measurement and Instruments
2. **New timekeeping system and its time link calibration at NIM.** Liang, Kun; Zhang, Aimin; Wang, Weibo; Ning, Dayu; Gao, Yuan; Yang, Zhiqiang; Zhao, Kejia; Zhang, Yue; Liu, Kun;

Long, Bo Source: IFCS 2014 - 2014 IEEE International Frequency Control Symposium, Proceedings, 2014, IFCS 2014 - 2014 IEEE International Frequency Control Symposium, Proceedings

3. **Research on modification of H-maser drift.** Aimin, Zhang (Time and Frequency Division, National Institute of Metrology, Beijing, China); Weibo, Wang; Yuan, Gao; Kun, Liang; Zhiqiang, Yang; Kun, Liu Source: IFCS 2014 - 2014 IEEE International Frequency Control Symposium, Proceedings, 2014, IFCS 2014 - 2014 IEEE International Frequency Control Symposium, Proceedings
4. **Processing Method of Clock Break in VLBI Data Analysis.** Lei, Han (State Key Laboratory of Astronautic Dynamics, Xi'an, China); Cao, Lu; Xu, Ke; Wang, Chong Source: Lecture Notes in Electrical Engineering, v 497, p 561-571, 2018, China Satellite Navigation Conference (CSNC) 2018 Proceedings - Volume

◇原子钟技术

1. **Atomic clock frequency difference prediction algorithm based on genetic wavelet neural network.** Jiangmiao, Zhu (Faculty of Information Technology of Beijing University of Technology, 100124, China); Ye, Chen; Yuan, Gao; Yuzhuo, Wang; Di, Yan Source: ICEMI 2017 - Proceedings of IEEE 13th International Conference on Electronic