PIBB 生物化学与生物物理进展
Progress in Biochemistry and Biophysics
2023,50(12):2791
www.pibb.ac.cn

Optically Pumped Magnetometer Lights up The Era of Vector Detection for Magnetoencephalography: an Experimental Evidence

DOI: 10.16476/j.pibb.2023.0446

Since its emergence half a century ago, magnetoencephalography (MEG) technology has been recognized as one of the most ideal non-invasive measures to explore functional brain activities[1]. However, its subsequent development has fallen short of expectations, *e. g.*, with much fewer installations compared to electroencephalography or functional magnetic resonance imaging systems. The main obstacle stems from traditional MEG being built around superconducting quantum interference devices (SQUID), which, due to its ultra-low temperature design, not only incurs high construction and operation costs but also limits magnetic signal detection to only one direction (radial) [2]. As brain magnetic signals are essentially vectorial, fixed-direction, scalar-based detection undoubtedly results in a loss of information in either direction or magnitude.

In recent years, the emergence of a new, room-temperature weak magnetic detection technology based on new physical principles has brought promise to overcome the aforementioned issues[3]. Here we focus on signal detection. The core device of this technology is a sensor named optically pumped magnetometer (OPM, also known as atomic magnetometer), which currently enables synchronous detection in at least two orthogonal axes, with no major obstacles to achieving three-axial detection in the future[4].

Wang *et al*. (Prog Biochem Biophys, 2023, **50**(12): 3023-3031. DOI: 10.16476/j. pibb. 2023.0438) employed bi-axis OPMs to collect brain magnetic signals in two orthogonal directions. They utilized an experimental paradigm of auditory frequency following responses to observe healthy subjects. Data analysis confirmed that bi-axial detection can obtain richer information than traditional single-axis MEG detection. These results suggest that the new MEG system based on OPM is expected to have the ability of vector detection, thus obtaining more comprehensive brain magnetic signals. The foreseeable impacts of OPM-MEG include optimizing or rewriting the traditional models of neural electrical activities established based on radial single-axis MEG recordings, gaining wider applications in brain functional imaging and the diagnosis of psychiatric/neurological diseases, as well as becoming a new carrier for techniques such as brain-computer interfaces. Although this research is not a comprehensive one, it is convincing enough to envision us the future of OPM-MEG replacing SQUID-MEG, becoming a more popular and influential brain imaging technology. At the same time, it reminds us that the development of multi-axis detection technology for OPM-MEG and the development of related experimental paradigms are research directions worthy of more attention in the field of brain imaging.

References

[1] Cohen D. Magnetoencephalography: evidence of magnetic fifields produced by alpha-rhythm currents. Science, 1968, **161**(3843): 784-786

[2] Baillet S. Magnetoencephalography for brain electrophysiology and imaging. Nat Neurosci, 2017, **20**(3): 327-339

[3] Boto E, Meyer S S, Shah V, *et al*. A new generation of magnetoencephalography: room temperature measurements using optically-pumped magnetometers. Neuroimage, 2017, **149**: 404-414

[4] Brookes M J, Boto E, Rea M, *et al*. Theoretical advantages of a triaxial optically pumped magnetometer magnetoencephalography system. Neuroimage, 2021, **236**:118025

ZHUO Yan
State Key Laboratory of Brain and Cognition Sciences, Institute of Biophysics, Chinese Academy of Sciences, Beijing 100101, China

Tel: 86-10-64838468, E-mail: yzhuo@ibp.ac.cn
Received: November 13, 2023 Accepted: November 15, 2023