

技术及应用

# 100 MeV强流质子回旋加速器主磁铁电磁力的数值模拟

杨建俊<sup>1,2</sup>, 张天爵<sup>1</sup>, 钟俊晴<sup>1</sup>

- 1. 中国原子能科学研究院 串列加速器升级工程技术部, 北京 102413
- 2. 清华大学 工程物理系, 北京 100084

收稿日期 2006-10-13 修回日期 2006-12-26 网络版发布日期: 2008-2-20

**摘要** 本工作研究计算中国原子能科学研究院目前正在设计、建造中的100 MeV强流质子回旋加速器CYCIAE-100主磁铁电磁力。计算中选用虚位移法和麦克斯韦应力张量法两种方法。在利用电磁场三维有限元分析程序计算得到紧凑型等时性回旋加速器主磁铁电磁场的基础上, 先采用虚位移法估算电磁吸力, 然后基于麦克斯韦应力张量法在MATLAB环境下编写数值计算程序, 详细研究磁极和磁轭受到的电磁吸力。两种方法的计算结果接近。计算得到的主磁铁磁极间吸力大于磁极与盖板间吸力, 二者之差由磁极和盖板间的螺栓承担。电磁力的计算结果为主磁铁结构变形计算和结构方案选取提供了依据。

关键词 [电磁力](#) [麦克斯韦应力张量法](#) [虚位移法](#) [回旋加速器](#)

分类号 [TL503.8](#)

## Numerical Calculation of Electromagnetic Force for 100 MeV H- Cyclotron

YANG Jian-jun<sup>1, 2</sup>, ZHANG Tian-jue<sup>1</sup>, ZHONG Jun-qing<sup>1</sup>

- 1. China Institute of Atomic Energy, P. O. Box 275-3, Beijing 102413, China;
- 2. Department of Engineering Physics, Tsinghua University, Beijing 100084, China

**Abstract** A 100 MeV compact proton cyclotron CYCIAE-100 is under design and construction at China Institute of Atomic Energy. The electromagnetic force of the machine was numerically investigated via virtual work method and Maxwell stress tensor method. In practice, the magnetic field distribution was achieved from a FEM code and we got an estimation of the electromagnetic force through virtual work method. Then a new code was written based on Maxwell stress tensor method and implemented in MATLAB environment. The code was used to calculate the electromagnetic force numerically for detailed study. It shows that the results of two different methods are comparable. The attractive force between two opposite poles is larger than the attractive force between a pole and top/bottom yoke, and the difference of the two forces is borne by the bolts which fix the pole on the yoke. This study provides foundation for the calculation of magnet deformation and selection of mechanical structure.

**Key words** [electromagnetic force](#); [Maxwell stress tensor method](#); [virtual work method](#); [cyclotron](#)

DOI

扩展功能	
本文信息	
▶ <a href="#">Supporting info</a>	
▶ <a href="#">[PDF全文](136KB)</a>	
▶ <a href="#">[HTML全文](0KB)</a>	
▶ <a href="#">参考文献</a>	
服务与反馈	
▶ <a href="#">把本文推荐给朋友</a>	
▶ <a href="#">文章反馈</a>	
▶ <a href="#">浏览反馈信息</a>	
相关信息	
▶ <a href="#">本刊中 包含“电磁力”的 相关文章</a>	
▶ 本文作者相关文章	
· <a href="#">杨建俊</a>	
· <a href="#">张天爵</a>	
· <a href="#">钟俊晴</a>	