

Accurate Biot-Savart Routines with Correct Asymptotic Behaviour

Jonathan Schilling^{a,*}, Jakob Svensson¹, Joachim Geiger¹

^a*Max Planck Institute for Plasma Physics, Wendelsteinstrasse 1, 17489 Greifswald, Germany*

Abstract

A set of routines to compute the magnetic vector potential and magnetic field of two types of current carriers is presented. The (infinitely thin) current carrier types are a straight wire segment and a circular wire loop. The routines are highly accurate and exhibit the correct asymptotic behaviour far away from and close to the current carrier. A suitable global set of test points is introduced and the methods presented in this work are tested against results obtained using arbitrary-precision arithmetic on all test points. The results are accurate to approximately 16 decimal digits of precision when computed using 64 bit floating point arithmetic, with few exceptions where accuracy drops to 12 digits. These primitive types can be used to make up more complex current carrier arrangements, such as a current along a polygon (by means of defining straight wire segments from point to point of the polygon) and a multi-winding coil with circular cross-section (by positioning circular wire loops at appropriate positions in the coils cross-section). Reference data is provided along with the code to compute it for testing the reader's routines against this work.

Keywords: magnetostatics; Biot-Savart; straight wire segment; circular wire loop; magnetic vector potential; magnetic field

PROGRAM SUMMARY

Program Title: Accurate Biot-Savart Routines with Correct Asymptotic Behaviour
CPC Library link to program files: (to be added by Technical Editor)

*Corresponding author.

E-mail address: jonathan.schilling@ipp.mpg.de

Developer's repository link: <https://github.com/jonathanschilling/abscab>

Code Ocean capsule: (to be added by Technical Editor)

Licensing provisions(please choose one): Apache-2.0

Programming language: C

Supplementary material:

Nature of problem(approx. 50-250 words):

Solution method(approx. 50-250 words):

Additional comments including restrictions and unusual features (approx. 50-250 words):

References

[1] Reference 1

[2] Reference 2

[3] Reference 3

1.