

# Getting Started With DiracQ

## What the Package Does

The DiracQ package is intended to provide a way to manipulate quantum mechanical operators and other noncommutative objects using Mathematica. This package excels at performing algebraic manipulations of noncommutative objects, specifically quantum mechanical operators, that are difficult or tedious to perform by hand. The package “knows” the properties of the operators and can utilize them to perform manipulations, calculations, and simplifications of expressions involving both numbers and variables that commute and operators, which do not commute.

## Loading the Package

We recommend saving all of the DiracQ files in a separate folder.

The package itself is the file “DiracQ\_V0.m”.

There are a number of methods to load this or any other Mathematica package. Instructions can be obtained through the Wolfram Documentation Center.

The method we use is saving the notebook in which you are currently working in the same folder as the package, “DiracQ\_V0.m”. When this is done the command below will load the package.

```
SetDirectory[NotebookDirectory[]];  
Get["DiracQ_V0.m"];
```

If you see a warning regarding dynamic content, choose to allow dynamic content. The package allows the user to update options and settings dynamically, and there is no harm in running dynamic content.

## What You See When You Load the Package

The package should automatically open a palette. If the palette doesn't open, then the package has not loaded, or there has been some other error. The palette should look like other *Mathematica* palettes. The palette allows the user to control the operation of some of the functions of the package.

The most important thing the package does is allow the user to specify what symbols should be viewed as operators. Initially no symbols will be viewed as operators. This may seem inconvenient but we think that it will lead to fewer mistakes than the alternative.

Checking the box next to an operator in the lower half of the palette will activate that operator. Now that symbol will be viewed as having the properties of the operator to which it corresponds.

## The Functions of the Package

The package provides a large number of functions. To understand what the package does only a small number of functions needs to be used.

- Commutator/AntiCommutator
- ProductQ
- SimplifyQ

To get information about a function, you can call the usage paragraph, as is done for other *Mathematica* functions. This can be done for any of the functions.

**? Commutator**

Commutator is used to calculate the commutators of expressions involving operators with known commutation relations. `Commutator[A,B]` is defined as  $AB-BA$ .

## Using the Functions

Our goal was to allow the user to write input as similar as possible to the way we write by hand. That being said, the notation used might take a little getting used to.

Operators need to have an argument, otherwise they will not be viewed as operators. This may seem inconvenient but

in practice it is not. The argument of an operator is usually used to specify an index, such as a site index. The example below shows how to calculate the anticommutator of two fermionic operators, one creation operator and one annihilation operator. Here we will assume that the operators act at the same site.

- Before evaluating the input below, check the box next to “Fermionic Operators” on the palette.

```
AntiCommutator[f[i], f†[i]]
```

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The answer should of course be unity. This calculation is not meant to be impressive, but if it works then you have successfully downloaded and loaded the package.

## Learning More About How to Use the Package

The package comes with several files :

- The package itself (DiracQ\_V0.m)
- This notebook (Getting\_Started\_V0.nb)
- A substantially more in depth tutorial of how to use the package (Tutoria\_V0.nb)
- A book of examples that demonstrate some of the interesting and useful ways the package can be applied to solving problems (Example\_Book\_V0.nb)
- A Glossary of all of the functions provided by the package (Glossary\_V0.nb)

Using the package to its fullest potential is somewhat complicated. We suggest using the Tutorial, Example Book, and Glossary to discover how this package might be useful to you.

It is probably best to use the Tutorial and Example Book to initially learn more about the package, and to use the Glossary as a reference.

The Tutorial contains simple examples that demonstrate how to use all of the features and functions of the package.

The Example Book contains more complicated applications of the functions of the package.

We encourage exploration of what the package does and what it can be made to do. We also encourage users to find ways to use the already extensive abilities of *Mathematica* in conjunction with the functions of the package to expediate or extend their problem solving abilities.