NOTES ON USING MATHEMATICA TO COMPUTE COMPLEX COEFFICIENTS

I have received several questions from students wondering why their *Mathematica* calculations seem to be off by a sign or do not seem to yield compact answers. One reason for this may be how *Mathematica* interprets the imaginary number. Let me illustrate by doing seemingly the same integral. Below are two examples of finding:

$$\frac{1}{2\pi}\int_{-\pi}^{\pi} x\, e^{-i n x}\, dx$$

```
In[6]:= Simplify[Integrate[x Exp[- i n x], {x, -π, π}] / (2 π), Assumptions → n ∈ Integers]
Out[6]= (-i n π Cosh[i n π] + Sinh[i n π]) / (i^2 n^2 π)
```

and now :

```
In[7]:= Simplify[Integrate[x Exp[- i n x], {x, -π, π}] / (2 π), Assumptions → n ∈ Integers]
Out[7]= i (-1)^n / n
```

Look carefully at these two input statements; clearly they must be different since they are generating very different output statements. The second output looks like the sort of compact coefficient you expect from a simple function; the first output looks much more complicated. What's the difference between the two? And why are they producing such different outputs?

The difference is found in the argument of the exponential; look carefully at how "i" is written. In the first input statement, *Mathematica* inteprets "i" as simply another undefined constant. In the second input statement, I typed ESC ii ESC (esc ii esc); this symbol will be interpreted as the complex number. To show this further, consider:

```
In[8]:= i i
Out[8]= i^2

In[9]:= i i
Out[9]= -1
```

The single "i" is interpreted simply as a symbol; the ESC ii ESC is interpreted as $\sqrt{-1}$. Check in your calcuations to see if this will make a difference.