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The screenshot displays the Wolfram Publicon interface with a document titled "Article1Sample.nb". The document content includes:

**1.2 The Hill Determinant Method**

A classical method to solve Sturm-Liouville problems of type 1 is to calculate the eigenvalues of a truncated version of the corresponding Hill determinant. Using the harmonic oscillator basis  $\phi_n(x)$  we write  $\psi(x) = \sum_{n=0}^{\infty} a_n \phi_n(x)$  where

$$-\psi''(x) + x^2 \phi_n(x) = \epsilon_n \phi_n(x) \quad (2)$$

$$\phi_n(x) = \frac{1}{\sqrt{\pi^{1/2} 2^n n!}} e^{-x^2/2} H_n(x) \quad (3)$$

Forming the matrix elements  $h_{mn} = \int_{-\infty}^{\infty} \phi_m(x) (-\psi''(x) + x^2 \phi_n(x)) dx$ . For  $n \geq m$  we obtain

$$h_{mn} = \begin{cases} 0 & n = m + 4 \\ 2 \frac{m+1}{2} \sqrt{\frac{m+1}{m}} (32n^2 \delta_{m,n-2} (n-1)^2 + 16(n-3)(n-2) \delta_{m,n-4} (n-1) + \epsilon_n) & n = m + 4 \\ 4(2n(3n+3) + 3) \delta_{m,n} + 8(n+1) \delta_{m,n+2} + \delta_{m,n+4} & \end{cases} \quad (4)$$

A rough estimation shows that one obtains about 0.2 digits per harmonic oscillator state. So by taking into account the first 500 eigenstates and carrying out the calculation with about five thousand digits one obtains about 120 reliable digits for  $\epsilon_0$ . (This calculation takes about 20 minutes on a 2000 vintage workstation using Mathematica 4 [Wolfram99].)

$$\epsilon_0 = 1.0603620904841828996470460166926635455120072852897793216243241695943563044... 344211268962991346717031054624435822558096276329...$$

The Hill determinant approach allows in addition to the calculation of the eigenvalues, the calculation of the eigenvectors. The following graphic visualizes the matrix of eigenvectors of  $(h_{mn})_{n,m=0,100}$ . The graphic shows that the lowest eigenfunctions are quite similar to the harmonic oscillator eigenfunctions. Higher states are complicated mixtures of harmonic oscillator states. The overall "checkerboard"-like structure results from the fact that the contribution of the antisymmetric (symmetric) harmonic oscillator states to the symmetric (antisymmetric) subharmonic oscillator states is identical zero. The very high states are dominated by truncation effects and do not correctly mimic the subharmonic oscillator states.

Figure 1: The matrix of eigenvectors of  $(h_{mn})_{n,m=0,100}$

**1.3 The New Algorithm**

To get a very high-precision approximation of

$$-\psi''(x) + x^2 \psi(x) = \lambda \psi(x) \quad (5)$$

we start with the series expansion

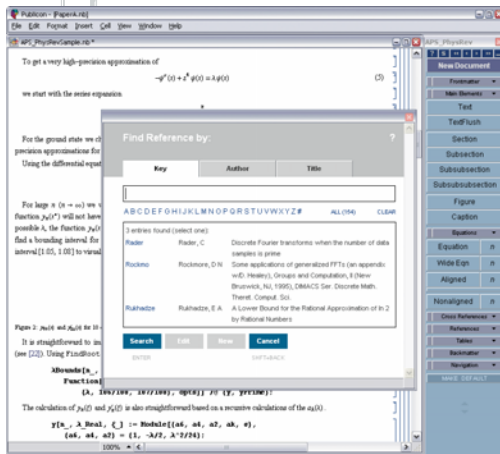
$$\psi(x) = \sum_{n=0}^{\infty} a_n(x) x^n \quad (6)$$

The interface also shows a "Default" palette on the right with options like "New Document", "Frontmatter", "Main Elements", "Text", "Section", "Subsection", "Subsubsection", "Lists", "Equations", "Equation", "Aligned", "Nonaligned", "Cross References", "References", "Insert Note", "Insert Reference", "Gather Backmatter", "Restore Citations", "Graphics", "Tables", "Backmatter", "Outlining", and "Navigation".

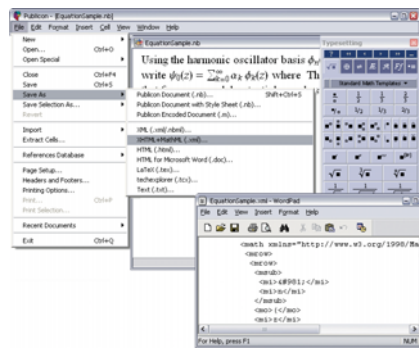
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# WolframPublicon



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