Bayesian Analysis Users Guide
Release 4.00, Manual Version 1

G. Larry Bretthorst
Biomedical MR Laboratory
Washington University School Of Medicine,
Campus Box 8227
Room 2313, East Bldg.,
4525 Scott Ave.
St. Louis MO 63110
http://bayes.wustl.edu
Email: larry@bayes.wustl.edu

August 21, 2013
# Contents

Manual Status 14

1 An Overview Of The Bayesian Analysis Software 17
   1.1 The Server Software ............................... 17
   1.2 The Client Interface ................................ 20
      1.2.1 The Global Pull Down Menus ....................... 22
      1.2.2 The Package Interface ............................ 22
      1.2.3 The Viewers .................................. 25

2 Installing the Software 27

3 the Client Interface 29
   3.1 The Global Pull Down Menus ............................ 31
      3.1.1 the Files menu .................................. 31
      3.1.2 the Packages menu ................................. 36
      3.1.3 the WorkDir menu ................................ 41
      3.1.4 the Settings menu ................................ 42
      3.1.5 the Utilities menu ................................ 46
      3.1.6 the Help menu ................................... 47
   3.2 The Submit Job To Server area ........................... 47
   3.3 The Server area .................................... 48
   3.4 Interface Viewers ................................... 49
      3.4.1 the Ascii Data Viewer ............................... 49
      3.4.2 the fid Data Viewer ................................. 51
      3.4.3 Image Viewer .................................... 56
         3.4.3.1 the Image List area ............................. 56
         3.4.3.2 the Set Image area .............................. 58
         3.4.3.3 the Image Viewing area ......................... 58
         3.4.3.4 the Grayscale area on the bottom ................ 60
         3.4.3.5 the Pixel Info area ............................. 60
         3.4.3.6 the Image Statistics area ....................... 60
      3.4.4 Prior Viewer ..................................... 62
      3.4.5 fid Model Viewer ................................. 65
         3.4.5.1 The fid Model Format ......................... 65


3.4.5.2 The Fid Model Reports ................................................. 67
3.4.6 Plot Results Viewer .................................................. 68
  3.4.6.1 the Data, Model and Residuals Plots ............................ 70
  3.4.6.2 the Posterior Probabilities Plots ................................. 71
3.4.7 the Posterior Probability Vs Parameter Samples plot .......... 72
  3.4.7.1 the Expected Log Likelihood Plot ............................... 75
  3.4.7.2 the Scatter Plots ................................................ 75
  3.4.7.3 the Log Probability Plot ....................................... 78
3.4.8 Text Results Viewer .................................................. 80
3.4.9 Files Viewer .......................................................... 86
3.4.10 Fortran/C Code Viewer ............................................. 86
  3.4.10.1 Fortran/C Model Viewer Popup Editor ......................... 88
4 An Introduction to Bayesian Probability Theory ..................... 91
  4.1 The Rules of Probability Theory ..................................... 91
  4.2 Assigning Probabilities .............................................. 94
  4.3 Example: Parameter Estimation ..................................... 101
    4.3.1 Define The Problem ............................................. 102
      4.3.1.1 The Discrete Fourier Transform .......................... 102
      4.3.1.2 Aliases ..................................................... 105
    4.3.2 State The Model—Single-Frequency Estimation ................. 106
    4.3.3 Apply Probability Theory ..................................... 107
    4.3.4 Assign The Probabilities ..................................... 110
    4.3.5 Evaluate The Sums and Integrals ............................... 112
    4.3.6 How Probability Generalizes The Discrete Fourier Transform 115
    4.3.7 Aliasing ....................................................... 118
    4.3.8 Parameter Estimates .......................................... 124
  4.4 Summary and Conclusions .......................................... 127
5 Given Exponential Model ............................................... 129
  5.1 The Bayesian Calculation .......................................... 131
  5.2 Outputs From The Given Exponential Package ..................... 133
6 Unknown Number of Exponentials .................................... 135
  6.1 The Bayesian Calculations .......................................... 137
  6.2 Outputs From The Unknown Number of Exponentials Package ...... 140
7 Inversion Recovery ..................................................... 143
  7.1 The Bayesian Calculation .......................................... 145
  7.2 Outputs From The Inversion Recovery Package ..................... 146
8 Bayes Analyze .......................................................... 147
  8.1 Bayes Model ......................................................... 151
  8.2 The Bayes Analyze Model Equation ................................ 153
  8.3 The Bayesian Calculations ......................................... 159
  8.4 Levenberg-Marquardt And Newton-Raphson ......................... 163
8.5 Outputs From The Bayes Analyze Package .............................................. 167
  8.5.1 The “bayes.params.nnnn” and “bayes.model.nnnn” Files ....................... 169
    8.5.1.1 The Bayes Analyze File Header ........................................... 169
    8.5.1.2 The Global Parameters ...................................................... 174
    8.5.1.3 The Model Components ...................................................... 175
  8.5.2 The “bayes.output.nnnn” File ..................................................... 177
  8.5.3 The “bayes.probabilities.nnnn” File ............................................ 181
  8.5.4 The “bayes.log.nnnn” File ........................................................ 184
  8.5.5 The “bayes.status.nnnn” and “bayes.accepted.nnnn” Files .................... 187
    8.5.5.1 The “bayes.model.nnnn” File .............................................. 188
  8.5.6 The “bayes.summary1.nnnn” File ............................................... 189
  8.5.7 The “bayes.summary2.nnnn” File ............................................... 190
  8.5.8 The “bayes.summary3.nnnn” File ............................................... 191
  8.6 Bayes Analyze Error Messages ....................................................... 192

9 Big Peak/Little Peak ................................................................. 197
  9.1 The Bayesian Calculation ............................................................ 199
  9.2 Outputs From The Big Peak/Little Peak Package ................................ 206

10 Metabolic Analysis ................................................................. 209
  10.1 The Metabolic Model ............................................................... 213
  10.2 The Bayesian Calculation ........................................................ 215
  10.3 The Metabolite Models ............................................................. 218
    10.3.1 The IPGD_D2O Metabolite ...................................................... 218
    10.3.2 The Glutamate.2.0 Metabolite .............................................. 222
    10.3.3 The Glutamate.3.0 Metabolite .............................................. 225
  10.4 The Example Metabolite ............................................................ 226
  10.5 Outputs From The Bayes Metabolite Package ................................... 228

11 Find Resonances ................................................................. 229
  11.1 The Bayesian Calculations ....................................................... 231
  11.2 Outputs From The Bayes Find Resonances Package .............................. 236

12 Diffusion Tensor Analysis ....................................................... 237
  12.1 The Bayesian Calculation ........................................................ 239
  12.2 Using The Package ............................................................... 244

13 Big Magnetization Transfer ....................................................... 249
  13.1 The Bayesian Calculation ........................................................ 249
  13.2 Outputs From The Big Magnetization Transfer Package ......................... 252

14 Magnetization Transfer ............................................................ 255
  14.1 The Bayesian Calculation ........................................................ 257
  14.2 Using The Package ............................................................... 261
### List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>The Start Up Window</td>
<td>21</td>
</tr>
<tr>
<td>1.2</td>
<td>Example Package Interface</td>
<td>23</td>
</tr>
<tr>
<td>3.1</td>
<td>The Start Up Window</td>
<td>30</td>
</tr>
<tr>
<td>3.2</td>
<td>The Files Menu</td>
<td>31</td>
</tr>
<tr>
<td>3.3</td>
<td>The Load Image Selection Menu</td>
<td>33</td>
</tr>
<tr>
<td>3.4</td>
<td>The Packages Menu</td>
<td>37</td>
</tr>
<tr>
<td>3.5</td>
<td>The Working Directory Pull Down Menu</td>
<td>42</td>
</tr>
<tr>
<td>3.6</td>
<td>The Working Directory Pop up</td>
<td>43</td>
</tr>
<tr>
<td>3.7</td>
<td>The Settings Pull Down Menu</td>
<td>44</td>
</tr>
<tr>
<td>3.8</td>
<td>The McMC Parameters Pop up</td>
<td>44</td>
</tr>
<tr>
<td>3.9</td>
<td>The Edit Server Popup</td>
<td>45</td>
</tr>
<tr>
<td>3.10</td>
<td>The Submit Job Widget Group</td>
<td>48</td>
</tr>
<tr>
<td>3.11</td>
<td>The Server Widget Group</td>
<td>49</td>
</tr>
<tr>
<td>3.12</td>
<td>the Ascii Data viewer</td>
<td>50</td>
</tr>
<tr>
<td>3.13</td>
<td>the fid Data viewer</td>
<td>52</td>
</tr>
<tr>
<td>3.14</td>
<td>The Fid Data Viewer Display Type</td>
<td>53</td>
</tr>
<tr>
<td>3.15</td>
<td>The Fid Data Viewer the Options Menu</td>
<td>54</td>
</tr>
<tr>
<td>3.16</td>
<td>The Image Viewer</td>
<td>57</td>
</tr>
<tr>
<td>3.17</td>
<td>The Image Viewer Right Mouse Menu</td>
<td>58</td>
</tr>
<tr>
<td>3.18</td>
<td>The Prior Viewer</td>
<td>63</td>
</tr>
<tr>
<td>3.19</td>
<td>The Fid Model Viewer</td>
<td>66</td>
</tr>
<tr>
<td>3.20</td>
<td>The Data Model and Residuals</td>
<td>69</td>
</tr>
<tr>
<td>3.21</td>
<td>The Plot Information popup</td>
<td>70</td>
</tr>
<tr>
<td>3.22</td>
<td>The Posterior Probabilities</td>
<td>71</td>
</tr>
<tr>
<td>3.23</td>
<td>The Posterior Probabilities Vs Parameter Value</td>
<td>73</td>
</tr>
<tr>
<td>3.24</td>
<td>The Posterior Probabilities Vs Parameter Value a Skewed Example</td>
<td>74</td>
</tr>
<tr>
<td>3.25</td>
<td>The Expected Log Likelihood</td>
<td>76</td>
</tr>
<tr>
<td>3.26</td>
<td>The Scatter Plots</td>
<td>77</td>
</tr>
<tr>
<td>3.27</td>
<td>The Log Probability Plot</td>
<td>79</td>
</tr>
<tr>
<td>3.28</td>
<td>The Text Results Viewer</td>
<td>81</td>
</tr>
<tr>
<td>3.29</td>
<td>The Bayes Condensed File</td>
<td>84</td>
</tr>
<tr>
<td>3.30</td>
<td>Fortran/C Model Viewer</td>
<td>87</td>
</tr>
<tr>
<td>3.31</td>
<td>Fortran/C Model Viewer</td>
<td>88</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>4.1</td>
<td>Frequency Estimation Using The DFT</td>
<td>104</td>
</tr>
<tr>
<td>4.2</td>
<td>Aliases</td>
<td>105</td>
</tr>
<tr>
<td>4.3</td>
<td>Nonuniformly Nonsimultaneously Sampled Sinusoid</td>
<td>119</td>
</tr>
<tr>
<td>4.4</td>
<td>Alias Spacing</td>
<td>120</td>
</tr>
<tr>
<td>4.5</td>
<td>Which Is The Critical Time</td>
<td>122</td>
</tr>
<tr>
<td>4.6</td>
<td>Example, Frequency Estimation</td>
<td>123</td>
</tr>
<tr>
<td>4.7</td>
<td>Estimating The Sinusoids Parameters</td>
<td>125</td>
</tr>
<tr>
<td>5.1</td>
<td>the Exponential interface</td>
<td>130</td>
</tr>
<tr>
<td>6.1</td>
<td>the Unknown Exponential interface</td>
<td>136</td>
</tr>
<tr>
<td>6.2</td>
<td>The Distribution of Models</td>
<td>141</td>
</tr>
<tr>
<td>6.3</td>
<td>Exponential Probability for the Model</td>
<td>142</td>
</tr>
<tr>
<td>7.1</td>
<td>the Inversion Recovery interface</td>
<td>144</td>
</tr>
<tr>
<td>8.1</td>
<td>Bayes Analyze Interface</td>
<td>148</td>
</tr>
<tr>
<td>8.2</td>
<td>Bayes Analyze Fid Model Viewer</td>
<td>152</td>
</tr>
<tr>
<td>8.3</td>
<td>The Bayes Analyze File</td>
<td>170</td>
</tr>
<tr>
<td>8.4</td>
<td>The bayes.noise File</td>
<td>172</td>
</tr>
<tr>
<td>8.5</td>
<td>Bayes Analyze Global Parameters</td>
<td>175</td>
</tr>
<tr>
<td>8.6</td>
<td>Bayes Analyze Model File</td>
<td>176</td>
</tr>
<tr>
<td>8.7</td>
<td>Bayes Analyze Initial Model</td>
<td>178</td>
</tr>
<tr>
<td>8.8</td>
<td>Base 10 Logarithm Of The Odds</td>
<td>178</td>
</tr>
<tr>
<td>8.9</td>
<td>The bayes.output.mnnn Report</td>
<td>179</td>
</tr>
<tr>
<td>8.10</td>
<td>Bayes Analyze Uncorrelated Output</td>
<td>180</td>
</tr>
<tr>
<td>8.11</td>
<td>The bayes.probabilities.mnnn File</td>
<td>182</td>
</tr>
<tr>
<td>8.12</td>
<td>The bayes.log.mnnn File</td>
<td>185</td>
</tr>
<tr>
<td>8.13</td>
<td>The bayes.status.mnnn File</td>
<td>187</td>
</tr>
<tr>
<td>8.14</td>
<td>The bayes.model.mnnn File</td>
<td>188</td>
</tr>
<tr>
<td>8.15</td>
<td>The bayes.model.mnnn File Uncorrelated Resonances</td>
<td>189</td>
</tr>
<tr>
<td>8.16</td>
<td>Bayes Analyze Summary Header</td>
<td>189</td>
</tr>
<tr>
<td>8.17</td>
<td>The Summary2 Report</td>
<td>190</td>
</tr>
<tr>
<td>8.18</td>
<td>The Summary2 Report</td>
<td>191</td>
</tr>
<tr>
<td>9.1</td>
<td>The Big Peak/Little Peak Interface</td>
<td>198</td>
</tr>
<tr>
<td>9.2</td>
<td>The Time Dependent Parameters</td>
<td>208</td>
</tr>
<tr>
<td>10.1</td>
<td>The Bayes Metabolite Interface</td>
<td>210</td>
</tr>
<tr>
<td>10.2</td>
<td>Bayes Metabolite Viewer</td>
<td>212</td>
</tr>
<tr>
<td>10.3</td>
<td>Bayes Metabolite Probabilities List</td>
<td>217</td>
</tr>
<tr>
<td>10.4</td>
<td>The IPGD_D20 Metabolite</td>
<td>219</td>
</tr>
<tr>
<td>10.5</td>
<td>Bayes Metabolite IPGD_D20 Spectrum</td>
<td>220</td>
</tr>
<tr>
<td>10.6</td>
<td>Bayes Metabolite, The Fraction of Glucose</td>
<td>221</td>
</tr>
<tr>
<td>10.7</td>
<td>Glutamate Example Spectrum</td>
<td>223</td>
</tr>
<tr>
<td>10.8</td>
<td>Estimating The ( F_{c0} ), ( y ) and ( F_{a0} ) Parameters</td>
<td>226</td>
</tr>
<tr>
<td>10.9</td>
<td>Bayes Metabolite, The Ethyl Ether Example</td>
<td>227</td>
</tr>
</tbody>
</table>
11.1 the Find Resonances Interface ................................................. 230
12.1 Diffusion Tensor Interface .................................................... 238
12.2 Diffusion Tensor Parameter Estimates ..................................... 246
12.3 Diffusion Tensor Posterior Probability For The Model ................ 246
13.1 The Big Magnetization Package Interface .................................. 250
13.2 Big Magnetization Transfer Example Fid .................................. 253
13.3 Big Magnetization Transfer Expansion ..................................... 253
13.4 Big Magnetization Transfer Peak Pick ...................................... 254
14.1 Magnetization Transfer Interface ............................................. 256
14.2 Magnetization Transfer Peak Pick .......................................... 262
14.3 Magnetization Transfer Example Data ...................................... 263
14.4 Magnetization Transfer Example Spectrum ................................. 264
15.1 Magnetization Transfer Kinetics Interface .................................. 268
15.2 Magnetization Transfer Kinetics Arrhenius Plot ......................... 274
15.3 Magnetization Transfer Kinetics Water Viscosity Table ............... 275
16.1 Given Polynomial Order Package Interface ............................... 278
16.2 Given Polynomial Order Scatter Plot ..................................... 284
17.1 Unknown Polynomial Order Interface ....................................... 286
17.2 The Distribution of Models ................................................... 290
17.3 Unknown Polynomial Order Package Posterior Probability .......... 292
18.1 Errors In Variables Interface .................................................. 296
18.2 Errors In Variables McMC Values File ................................... 302
19.1 the Behrens-Fisher Interface .................................................. 304
19.2 Behrens-Fisher Hypotheses Tested ......................................... 305
19.3 Behrens-Fisher Console Log ................................................. 315
19.4 Behrens-Fisher Status Listing .............................................. 316
19.5 Behrens-Fisher McMC Values File, The Preamble ....................... 317
19.6 Behrens-Fisher McMC Values File, The Middle ......................... 318
19.7 Behrens-Fisher McMC Values File, The End ............................ 319
20.1 Enter Ascii Model Interface .................................................... 322
21.1 Test Your Own Ascii Model Interface ...................................... 330
22.1 Ascii Model Selection Interface .............................................. 332
26.1 Absorption Model Images .................................................... 346
26.2 Bayes Phase Interface ....................................................... 347
26.3 Bayes Phase Listing ............................................................ 353
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.1</td>
<td>Nonlinear Phasing Example</td>
<td>356</td>
</tr>
<tr>
<td>27.2</td>
<td>Nonlinear Phasing Interface</td>
<td>360</td>
</tr>
<tr>
<td>28.1</td>
<td>Image Pixels Example</td>
<td>362</td>
</tr>
<tr>
<td>A.1</td>
<td>Ascii Data File Format</td>
<td>368</td>
</tr>
<tr>
<td>D.1</td>
<td>The McMC Values Report Header</td>
<td>386</td>
</tr>
<tr>
<td>D.2</td>
<td>McMC Values Report, The Middle</td>
<td>387</td>
</tr>
<tr>
<td>D.3</td>
<td>The McMC Values Report, The End</td>
<td>388</td>
</tr>
<tr>
<td>E.1</td>
<td>Writing Models A Fortran Example</td>
<td>392</td>
</tr>
<tr>
<td>E.2</td>
<td>Writing Models A C Example</td>
<td>393</td>
</tr>
<tr>
<td>E.3</td>
<td>Writing Models, The Parameter File</td>
<td>395</td>
</tr>
<tr>
<td>E.4</td>
<td>Writing Models Fortran Declarations</td>
<td>399</td>
</tr>
<tr>
<td>E.5</td>
<td>Writing Models Fortran Example</td>
<td>402</td>
</tr>
<tr>
<td>E.6</td>
<td>Writing Models The Parameter File</td>
<td>403</td>
</tr>
<tr>
<td>G.1</td>
<td>The FD File Header</td>
<td>409</td>
</tr>
<tr>
<td>H.1</td>
<td>the Posterior Probability for the Number of Outliers</td>
<td>412</td>
</tr>
<tr>
<td>H.2</td>
<td>The Data, Model and Residual Plot With Outliers</td>
<td>414</td>
</tr>
</tbody>
</table>
## List of Tables

8.1 Multiplet Relative Amplitudes ................................................. 157  
8.2 Bayes Analyze Models ................................................................. 173  
8.3 Bayes Analyze Short Descriptions ............................................. 186
Chapter 28

Analyze Image Pixel

The Analyze Image Pixel package allows you to enter a model of your own and then use Bayesian probability theory to analyze that model. The Java interface to the Image Pixel package is shown in Fig. 28.1. The Bayesian calculations performed by this package are identical to those in Bayes Enter Asci, Chapter 20, and consequently we are not going to repeat those calculation here; rather in this Chapter we will concentrate our attention on the problem of how to use this package. To use this package, you must do the following:

Select the “Analyze Image Pixel” package from the Package menu.

Load the image data that is to be processed by the package. The analyze image Pixel package analyzes arrayed images on a pixel by pixel basis.

Load a Fortran or C model using the “System” or “User” buttons in the “Load And Build Model” widget group.

Load an abscissa file. A typical arrayed image data set is a stack of images each gathered at some parameter settings. For example, if the data are diffusion tensor data, then the abscissa would be a vector specifying the $b$ values for each element in the array. These $b$ values would be $b_x$, $b_y$, and $b_z$. So the abscissa file would be a three column Ascii file containing the $b$ values each element in the array. In general the user specifies the number of abscissa columns, See Chapter A.3 for more on the abscissa file. Note the Analyze Image Pixel package uses the same abscissa for every pixel in the data.

Build the model using the “Build” button.

Check the Analysis Options boxes as you see fit.

Find Outliers tells the package to use an outlier model to select and eliminate pixels with odd characteristics.

---

I would like to build a system library of predefined models. If you have models that you think would be of general use, I would like to hear from you. To have one of your models included, I would need the source code, the parameter file, a brief description of the model equations and data requirements.
Figure 28.1: Loading models for the Image Pixel Package is the same as loading model in the Enter Ascii package. One selects either the system or user libraries and the loads a Fortran or C model. Loading images consists of simply loading the images to be analyzed. Prior to running an analysis, you must also load an appropriate Abscissa file. Finally, you must select the image that is to be analyzed prior to hitting the run button.
Max Probability tells the package to locate the maximum of the posterior probability. Locating the maximum is done using a searching algorithm and is much faster than using a Markov chain Monte Carlo algorithm. When Max Probability is selected the output images are generated using the parameters that maximized the posterior probability.

Use Gaussian tells the package to switch from using a $t$-distribution to using a Gaussian. In this case the input standard deviation of the noise is used as the standard deviation of the Gaussian likelihood. If Use Gaussian is not selected, a Students’ $t$-distribution is used for the likelihood. The input noise standard deviation is used to threshold pixels. Arrays of pixels having a root mean-square smaller than the input standard deviation of the noise are not processed.

Set the Noise SD to a value equal to your best estimate of the standard deviation of the noise in the image stack that is to be processed. To get an estimate of the noise standard deviation, draw an ROI in a region where there is no signal and hit the “Get Statistics” button. The output on the right-hand side labeled “RMS” contains the root mean-square image pixel value and is a good estimate of the noise standard deviation.

Review the prior probabilities for the loaded model using the Prior Viewer.

Select the server that is to process the analysis.

Check the status of the selected server to determine if the server is busy, change to another server.

Run the the analysis on the selected server by activating the Run button.

Get the the results of the analysis by activating the Get Job button. If the analysis is running, this button will return the Accepted report containing the status of the current run. Otherwise, it will fetch and display the results from the current analysis.

The actual processing done by this package are essentially the same as that done in the Bayes Enter Ascii package and we refer you to that package, Chapter 20, for more on the processing being done. However, there is one difference: the Analyze Image Pixel package does a model selection calculation. In this calculation there are two models: a No Signal model, and a signal model. The No Signal model assumes the signal consists of only noise while the signal model assumes the signal is given by your model plus noise. When the no signal model is selected, there are no output parameters. Output parameter maps contain zero in these no signal regions. However, there is an exception to this, on the output map containing the standard deviation of the noise, both signal and no signal regions have an estimate of the noise standard deviation. In regions with no signal, the standard deviation is computed as the root mean-square of the total data value. In regions containing signals, the output standard deviation is computed as the root means-square residual.

28.1 Modification History

In release 4.10, the Markov chain Monte Carlo routine in Bayes Image Pixels was replaced by one as similar to the one in the Enter Ascii Model package, Chapter 20, as possible. This was done because in some cases the Enter Ascii package’s Markov chain was able to solve problems that Bayes Image Pixel package could not. Given that the data and the model were identical in the cases at hand, I
concluded the Markov chain in Bayes Image Pixels package needed replacing. The new routine is almost line by line identical to the routine in the Enter Ascii package.

In addition to replacing the Markov chain, I also modified the output routines so that it tests each output image to see if it is null, i.e., all zero. If the image is zero everywhere nothing is written. This was done to eliminate a perceived problem. In the process of testing a new model, a user generated an image containing no signal and then ran the Bayes Image Pixel using the no signal image and his new model. The old Bayes Image Pixel package correctly identified the pixels as no signal and so set the output images to zero. When processing was complete, the output routines wrote these zero images, and the users, myself included, interpreted these zero output images as an error on the part of Bayes Image Pixels package. That interpretation was incorrect and as soon as I realized what was happening, I modified the output routines so that zero images are not written.
Bibliography


[43] Metropolis, Nicholas, Arianna W. Rosenbluth, Marshall N. Rosenbluth, Augusta H. Teller, and Edward Teller (1953), “Equation of State Calculations by Fast Computing Machines,” Journal of Chemical Physics. The previous link is to the American Institute of Physics and if you do not have access to Science Sitations you many not be able to retrieve this paper.


