MUSC4102

7 f]h]WU`DfUWh]WY`]b'Aig]W

HYfa 'Hk c''##'&\$&%

7ci fgY'Cj Yfj]Yk

GHJZZ7cbHJWh8YHJ]`g

7cbj Ybcfg

B Ua Y	9a U]`	5j U]`UV]`]lm	@cWJhjcb	D\cbY
GUbXm'9j Ubg	gUbXfU"Yj Ubg4 i bgk "YXi "Ui	7 cbgi `HUH]cb Vm Uddc]bha Ybh		

GWkcc~7cbhJWh~abZcfa Uh]cb

GVXcc``cZhY`5fhg`UbX`AYX]U

Fcca ' %&ž@YjY`' žFcVYfhK YVghYf6i]`X]b[fl %(Ł

D\cbY.'f\$&E'-',)'(,)*

9a U]`. 'gUa 4 i bgk "YXi "Ui

K YVg]hY. k k k "Ufhg"i bgk "YXi "Ui #gUa

 $\label{eq:hamiltonian} $$HY'GWKcc``cZhY'5ftg'UbX'AYX]U'kci`X``]_Y'hc'FYgdYWM\cong \cong m5W_bck`YX[Y'h\Y'HfUX]hjcbU``7ighcX]Ubgžh\Y'6YXY[U'`fPYbg]b[hcb'WJadigŁž'; UX][U'`fP]hmUbX'5fh\/'8Yg][b'7UadigYgŁ'UbX'h\Y'B[ibbUkU`dYcd'Y'fbighfU`]Ub'8YZYbW': cf\W'5\WJXYam]b'7UbVYffUŁ'cZh\Y'`UbXg'k\YfY'YUW\'WJadig'cZIBGK']g`c\WJhYX''$

7ci fgY 8YW] g

7 fYX]hDc]bhg**

Gi a a UfmcZh\Y'7ci fgY

H\Y'Wci fgY YbUV'Yg'mci 'hc'Yl hYbX'mci f'a UghYfmicZX]gW]d']bY!gdYW]ZW_bck 'YX[Y'UbX'dfUWf]WY'h\fci [\ Wf]h]WU''ghi X]Yg']b'a i g]W''Nci 'k]``'ghi Xma Yh\cXg'cZWf]h]WU''dfUWf]WY''hc'\Y'd'mci 'Z]bX'k Umg'hc']a dfcj Y'h\Y Yh\]WU''UbX'UYgh\Yh]WU''ci hWca Yg']b'mci f'W\cgYb'UfYU'cZdfUWf]WY''k\Yh\Yf']h]g'a i g]Wc'c[mž'dYXU[c[mž'dYXU[c]mž'dYZcfa UbWY'cf'Wca dcg]h]cb"'H\Y'Wci fgY'dfcj]XYg'U'Zcfi a 'Zcf'mci 'hc']bj Ygh][UhY'UgdYWg'cZmci f'UfYU'cZ a i g]WU''ghi Xm]b'h\Y'`][\hcZW ffYbhXYVUHYg'k]h\]b'h\Y'X]gW]d']bY"'\di ygh][UhY'UgdYWg'cZmci f'UfYU'cZ a i g]WU''ghi Xm]b'h\Y'`][\hcZW ffYbhXYVUHYg'k]h\]b'h\Y'X]gW]d']bY"'\di ygh][UhY'UgdYWg'cZmci f'UfYU'cZ a i g]Wa U_]b[žj]XYcgž'Ui X]c'fYWcfX]b[gžgWcfYg'UbX'di V']g\YX'fYgYUfW\"'Nci 'k]``U'gc'[U]b]b!XYdh\'ZJa]]']Uf]mk]h\'U'j Uf]YmcZUddfcUWXYg'hc'Wf]h]WU''dfUWf]WY']b'a i g]Wh\fci [\\h\Y']bX]j]Xi U''cf\\cfUh]g'Y'YI d'cfUh]cb'cZU'W\cgYb'dfc'Ywh\cbWfdhh\Uhk]``W'a]bUhY']b'U'gi a a Uh]j Y dfYqYbhUh]cb#dYfZcfa UbW'"

7ci fgY @YUfb]b['Ci hWca Yg

5ggYgga Ybh

5ggYgga YbhHUg_g

5ggYgga Ybh'hUg_	K Y][\h	8iY'8UhY	Gh XYbh@YUfb]b[CihWca Ygʻ5ggYggYX
DfcWgg'8]Ufmi	' \$1	K YY_'-	&
9j Ybh#DfYgYbhUhjcb) \$1	K YY_"%\$	% <u>~</u> ''
DfYdUfUhjcb Zcf WUgg	&\$ı	Bch5dd`]WUV`Y	% <u>*</u> &

5ggYgga Ybh8YhJ]`g

FYgci fWfg

DfYgWf]VYX F Ygci fWYg

D`YUgY`gYY`A ccX`Y`Zcf`k YY_`mifYgci fWYg"

FYWca a YbXYX FYgci fWYg

D`YUgY`gYY`A ccX`Y`Zcf`fYgci fWYg"

7ci fgY 9j U`i Uh]cb UbX 8Yj Y`cda Ybh

Ghi XYbhiZYXVUW_cbih\YiWti fgYik]```VYi[Uh\YfYXiZfca ih\YiWti fgYiYj U`i Uh]cbih\fci [\`a m9I dYf]YbWY": YYXVUW_'dfcj]XYXihciWti fgYiWtbj Ybcfgi]giUbcbma ci giUbXighi XYbhgiUfYik YiWta YihcigdYU_ihcih\YiWti fgYiWtbj Ybcficfih\YigWkccik]h\iUbmigdYW]ZWWtbWffbgicfi]ggi Yg"

Gi Va]gg]cb cZ5ggYgga YbhHUg_g Hi fb]h]b Gi Va]gg]cb

5 WUXYa]W<cbYghmUbX D`U[]Uf]ga

D`U[]Uf]ga `]g`i g]b['h\Y`k cfXg`cf`]XYUg`cZch\Yfg`UbX`dfYgYbh]b['h\Ya `Ug`mci f`ck b"`±hWJb`hU_Y`a Ubm Zcfa gžZfca `XY`]VYfUhY`W\YUh]b['hc`UWW]XYbhJ``mWcdm]b['Zfca `U`gci fWY`k]h\ci hUW_bck `YX[Ya Ybh'

IBGK [fcidg'd'U[]Uf]ga]bhc'h\Y'Zc``ck]b['WUhY[cf]Yg.

 $7 \text{ cdm}b[...i g]b[...h\Y.gUa Y.cf.j Yfmig]a] \Uf'k cfXg'hc'h\Y.cf][]bU''hYl h'cf']XYU'k]h\ci h'U\V_bck `YX[]b[...h\Y.cf][]bU''hYl h'cf']XYU'k]h'cf']$