

8]Y'Vf]h]gWXY'K YfVYUi Zg]WX hgVY\ÒfXY YfhY]`h'XYf'?fmdhc]bXi ghf]Y Ni fYWXhk Y]gi b[Yb

8]Y Vf]h]gWX Y K YfVYUi Zg]WX h\UhiX]Y ?fmd hc]bXi ghf]Y k Y[Yb k Y]hj YfVfY]hYhYf 'DfcV`Ya Y a]h]ffYZØ\fYbXYf'i bX i bj YfUbhk cfh`]WXYf K YfVi b['ni f`FYWXYbgWXUZh`[Ync[Yb i bX`I fhY]`Y`[Y[Yb'a Y\fYfY`XYf`[fÒ» hYb'I bhYfbY\a Yb'XYf 6fUbWXYžXUfi bhYf`7c]bVUgY'i bX`YHcfcžYf`UggYb''8]Y 5Xj Yfh]g]b['GhUbXUfXg'5i h\cf]hm`\Uh'Ua 'A]hhk cWX`g]YVYb I bhYfbY\a Yb'Zcfa Y``Y`FØ[Yb'k Y[Yb'JYfghc» Yg'[Y[Yb'X]Y GhUbXUfXg`XYf`Vf]h]gWXYb'5bnY][Yb]bXi ghf]Y'a]h'Y]bYf VfY]hYb'DU`YhhY'j cb'K YfVYU_h]cbYb'j YfÒZZYbh`]WXhž'j cb Cb`]bY!?Ua dU[bYb'V]g'\]b'ni '6]``][i b[Yb'Xi fWX`GcW]U`! A YX]U! \(\partial Z'i YbWYf'' DUdU'\partial \(\partial b') \) Ua d/, \(\partial k'' + /gž'X]Y'D]nnU_YhhYž X]Y'VY\Ui dhYhž'XYb'YfghYb'?Ui Z']b'6]hWc]b'U_nYdh]Yfh'ni \(\puVYbž'[Yf]Yh'j cb'XYf'FY[i `]Yfi b[gVY\OfXY'i bhYf 6YgWXi ggž'k Y]`'g]Y']\fYb'?i bXYb''\\$ DZi bX'6Uf[Y`X']b': cfa j cb'?fmdhc!Hc_Yb'Ub[YVchYb'\UhhY''' 8]Y'/ Ua d\(\partial Y'`)]d/

8]Y'Vf]h]gWXY'K YfVYUi Zg]WXh'\Uh'X]Y'?fmdhc]bXi ghf]Y'k Y[Yb' k Y]h j YfVfY]hYhYf 'DfcV`Ya Y'a]h']ffYZØ\fYbXYf'i bX'i bj YfUbhk cfh`]WXYf K YfVi b['ni f'FYWXYbgWXUZh'[Ync[Yb'i bX'I fhY]`Y'[Y[Yb'a Y\fYfY XYf'[fÒ»hYb'I bhYfbY\a Yb'XYf'6fUbWXYž'XUfi bhYf'7c]bVUgY'i bX YHcfcž'Yf`UggYb"

8]Y 5Xj Yfh]g]b['GhUbXUfXg'5i h\cf]hm'\Uh'Ua 'A]hhk cW\'g]YVYb I bhYfbY\a Yb 'Zcfa Y``Y 'FØ[Yb 'k Y[Yb 'J Yfghc » Yg'[Y[Yb 'X]Y GhUbXUfXg'XYf'Vf]h]gW\Yb '5bnY][Yb]bXi ghf]Y 'a]h'Y]bYf'VfY]hYb DU`YhhY'j cb 'K YfVYU_h]cbYb'j YfÒZZYbh`]W\hž'j cb 'Cb`]bY!? Ua dU[bYb'V]g'\]b'ni '6]``][i b[Yb 'Xi fW\'GcW]U`!A YX]U!

8 Yf '8 i fW gYhni b [ggW i V 'XYf '5 G5 '_ca a hž b U W XYa 'X]Y '5 [Ybhi f]ffY ZØ\fYb XYg '? fmd hc! A Uf_Yh]b ['ni f 'Df]cf]hÀh' 5 `Ufa ghi ZY 'F ch Yf_`Àfh'i b X 'j Yfgdfc W Yb '\ Uhž \ Ufh'Xi fW ni [fY]ZYb " '

5`g`k]f` 5`Ufa ghi ZY`F ch `gU[hYbž'a Y]bhYb`k]f`Yg`Yfbgh ž`gU[hY A]`Yg`@cW_k ccXž'8]fY_hcf`ZØf`6YgW\kYfXYb`i bX`I bhYfgi W\i b[Yb VY]`XYf`5G5" $^{\circ}$ = Cb`]bY!6YfY]W\`a i gg`g]W\`gW\bY```Yhk Ug ÀbXYfb"

@cW_k ccX`gU[hYžYf`[Y\Y`XUj cb`Ui gž`XUgg`g]W\`X]Y`a Y]ghYb
K YfVYhfY]VYbXYb`Ub`X]Y`DfÀnYXYbnZÀ``Y`\U`hYb`k YfXYbž`X]Y`Xi fW\
XUg`I fhY]``ZYgh[Y`Y[h`k i fXYbž`ZØ[hY`^YXcW\`\]bni ž`XUgg
I bhYfbY\a Yb`]b`bcfa U`Yfk Y]gY`gY`hYbYb`: À``Ybž`]b`XYbYb
I bhYfbY\a Yb`k]YXYf\c`h`X]Y`FY[Y`b`ni f`GW\Ui `ghY``Ybž`Ub`XUg
C ZZ]WY`cZ': U]f`HfUX]b['j Yfk]YgYb`k YfXYb`_ÒbbYbž`k Ug`ni `Y]bYf
ghfUZfYW\h`]W\Yb`J YfZc`[i b['ZØ\fYb`_Ubb"

I bhYfgi Wki b[Yb'XYf':]bUbW]U`'7cbXi Wh'5i h\cf]hm'\UVYb'Yf[YVYbž XUgg'bi f'Y]bY'A]bXYf\Y]h'XYf'A YbgWkYb'X][]hU'Y'A ØbnYb'Ui Z'XYf; fi bX`U[Y'j cb'K YfVi b['_Ui Zhž'UVYf'g]Y'bY][Yb'XUni ž'gWk'YWkhYfY 9f[YVb]ggY'ni 'Yfn]Y`Yb''' JYfVfUi WkYfž'X]Y'g]Wk'Xi fWk'K YfVi b[ØVYfnYi [Yb'`UggYbž'k YfXYb']\fYb'?Ui Z'j]Y`'Y\Yf'VYfYi Yb ž'hY]`hY X]Y': 75']a '\$\dangle b]'a]h''

8]Y'5G5'hY]'hY'XYf': H'a]hž'g]Y'\UVY' VYkiggh 'Y]bY'FY]\Y'j cb: À``Yb'Uig[YkÀ\`hž'ia'_`UfY'GhUbXUfXg'ZØf'XYb'g]W\'gW\bY`` ÀbXYfbXYb'GY_hcf'ni'gYhnYbž']bgVYgcbXYfY']b'6Yni['Ui Z'Cb`]bY! K YfVib["'

8]Y'5i Zg]W\hg\Y\\OfXY'_f]h]g]YfhY'I bhYfbY\a Yb'XUZØf \check{z} XUgg'g]Y ?fmdhc! \Rightarrow j Ygh]h]cbYb'U'g' Y]bZUW\'i bX'ZØf' Υ XYb'[YY][bYh

XUfghY``Ybži bX`gU[hYž`XUgg`K YfVi b['X]Y`FYU`]hÀh`k]XYfgd]Y[Y`b gc``hYž`XUgg`XYf'<UbXY``a]h'X][]hU`Yb`JYfa Ò[Ybgk YfhYb Ui g[YfY]Zhi bX`_ca d`Yl ']gh'i bX`i bYfZU\fYbY`Df]j UhUb`Y[YfgWXa Yfn\UZhYb`JYf`i ghYb`Ui ggYhnYb`_ÒbbhY"

Ni a '?fY]g'XYf': À``Y'[Y\ÒfhYb'Ui W\`I fhY]`Y'[Y[Yb'X]Y'<UbXY`g! 5dd'@ bc'i bX'X]Y'?fmdhc!6ÒfgY'?fU_Yb"'9]b'ZfØ\YfYg'5G5!I fhY]` j YfUb`UgghY'@ bcž'gY]bYb'K YfVY_Ua dU[bYb']b'XYb'@cbXcbYf $\tilde{O}ZYbh$]W\Yb'JYf_Y\fga]hhY`b'F]g]_c\]bk Y]gY'\]bni ni ZØ[Yb"'

± XYb j cb XYf 5G5 j YfÒZZYbh]W hYb 5bhk cfhYb a UW hYb a Y\fYfY XYf:]fa Yb ž XUfi bhYf @ bc ž: Y\ Yf c XYf J YfgÀi a b]ggY 8 f]hhYf ZØf XUg J YfgÀi a b]g j YfUbhk cfh]W ž F]g]_ck Ufbi b [Yb]b X]Y j ca K UhW Xc['\YfUi g[Y[f]ZZYbYb 5bnY][Yb Ui Zni bY\a Yb "9]bY FY]\Y j cb I bhYfbY\a Yb [UV Ub ž XUgg g]W X]Y 6Y\Ui dhi b [Yb XYf 9]b ZUW \Y]h Ui Z]\fY 8]Ybgh Y]ghi b [Yb VYnc[Yb i b X b]W h Ui Z ?fmdhc! ± j Ygh]h]cbYb gY Vgh"

7c]bVUgY'gU[hYžXYf'5i gXfi W_' Y]bZUWX'i bX``Y]WXh'ni 'j Yfk YbXYb]b'Y]bYf'gY]bYf'5bnY][Yb' VYnc['g]WX'b]WXh'Ui Z'X]Y ?fmdhck À\fi b['U`g'; UbnYg"'""UVYf'Ui Z']\fY'5dd'j Yfk]YgYb "DUdU'&\b g'gU[hYžX]Y'5bnY][Yb' a UWXhYb'_Y]bYb'?ca a YbhUf ni f'=bj Ygh]h]cb']b'6]hWc]b 'i bX'XUgg'X]Y'5_h]cb'Y]bYa 'GhUbXUfX! 7Ug\VUW_!5b[YVch'À\bY`hY"'

8]Y '5G5'ZcfXYfhY'I bhYfbY\a Yb'Ui W\'Ui Zz'_`Ufni ghY``Ybz'XUgg ?fmdhc!5ggYhg']b'; fc» Vf]hUbb]Yb'b]W\h'fY[i`]Yfh'g]bXz'i bX'?fmdhc! ?Ài ZYf'Ui Z']\fY'?Ud]hU`YfhfU[ghYi YfdZ']W\h'Ui Za Yf_gUa 'ni a UW\Ybz'XU' X]Y'VfY]hY'² ZZYbh`]W_Y]h'k U\fgW\Y]b`]W\'_Y]bY ?Ybbhb]g 'XYf'GhYi Yfj cfgW\f]ZhYb'\Uh"

YHcfc `\Uh'ni gUa a Yb'a]h'UbXYfYb':]fa Yb'X]Y'9fk Ufhi b[
ni fØW_[YXfÀb[hž'GhYi YfXYhU]`g'Ui Zni bY\a Yb"' ♣b'XYf'6fc_YfU[Y!
5dd `\Y]» h'Ygž'XUgg' Yg'_Y]bY'fY[i `Uhcf]gW\Y'; fi bX`U[Y 'ZØf'X]Y
5bZcfXYfi b['[YVY'i bX'XUgg'g]Y'b]W\h'ZØf'hfUX]h]cbY``Y
:]bUbndfcXi _hY'[]`hž'X]Y'j cb'XYf': 75'VYUi Zg]W\h][h'k YfXYb"

 $8\,]Y\,^{\prime}K\,\,YfVYfY\,[\,\,Y\,^{\backprime}b\,^{\prime}Z\!\!\varnothing f\,^{\prime}X\,]Y\,^{\prime}?\,fmd\,hc\,]b\,Xi\,\,ghf]Y\,^{\prime}_\grave{O}b\,b\,hY\,b\,^{\prime}g]W\!\!\lambda\,^{\prime}V\,U\,^{\backprime}X$

ÀbXYfbž'XU'XUg'Vf]h]gW\Y':]bUbna]b]ghYf]i a 'Ub[Y_ØbX][h'\Uhž'X]Y 5i Zg]W\h'XYf': 75'j cf'9bXY'XYg'\J\fYg'Ui Z'Y]b][Y'K YfVYU_h]cbYb ZØf'? fmdhc!5qqYhq'Ui qni XY\bYb"'

: 75!7\YZB]_\]``FUh\]`gU[hY``YhnhY`K cW\Y`j cf`XYb`5V[YcfXbYhYb XYg`:]bUbnUi ggW\i ggYg.` K]f`Yfk UfhYbž`XUgg`k]f`Y]b][Y`bYi Y 6YZ[b]ggY`]b`6Yni[`Ui Z`:]bUbnk YfVi b[`i bX`?fmdhc!5ggYhg Yf\U`hYb"

9]b][Y; YgYhn[YVYf`\UVYb`g]W\`g_Ydh]gW\`[YÀi »YfhžY]bZUW\
a Y\f`?`Y]b[YXfi W_hYg `ni `?fmdhc!<UZhi b[gUi ggW\`ØggYb\]bni ni ZØ[Yb"\8]Y\5V[YcfXbYhY'<Uff]Yh\6U`Xk]b`gU[hYžX]Y
JYfk YbXi b[`XYg`K cfhYg` \Deltaj Ygh]h]cb `]b`?fmdhc!F]g]_ck Ufbi b[Ybi bhYfghØhnY`X]Y`\XYYž`XUgg`X]Yg`Y]bY`\Deltaj Ygh]h]cb`]gh`i bX`a]h
Y]bYa : HG9!%\$\$!! bhYfbY\aYb`cXYf`Y]bYa \Deltaj Ygha YbhZcbXg
j Yf[`Y]W\VUf`]gh "

5bnY][Yb'ZØf':]bUbndfcXi _hYž'X]Y'j cb'XYf': 75'VYUi Zg]W\h][h k YfXYbž'a ØggYb'bcfa U`Yfk Y]gY'ni j cf'j cb'Y]bYf'Ui hcf]g]YfhYb:]fa U'[YbY\a][h'k YfXYbž'i bX'l bhYfbY\a Yb'_ObbYb'VY] gW\k Yfk]Y[YbXYb'J YfghO)» Yb'[Y[Yb'X]Y'GhUbXUfXg'XYf 5i Zg]W\hgVY\OfXY'a]h'; Y`XghfUZYb'VY`Y[h'k YfXYb''

8]Y'5G5'gU[hYž'g]Y'k YfXY']a 'bÀW ghYb'\J\f']b'Y]bYf
8i fWxgYhni b[ga]hhY]'i b['Ub'X]Y'6fUbWxY'i a ZUggYbXYfY
@Y]h']b]Yb'ni f'?fmdhc!K YfVi b['ZYgh'Y[Yb"'8]Y
FY[i `]Yfi b[gVY\ÒfXY'VYUVg]WXh][hž']\f'\UfhYg'8i fWx[fY]ZYb'Ui Z
?fmdhc!5ggYhg'k]Y'b]Wxh'Z b[]V'Y'Hc_Yb'i bX' : Ub!Hc_Yb
Ui gni k Y]hYbž'Y]bY': cfa 'XYf'?fmdhck À\fi b[ž'X]Y']\fYb'6Ybi hnYfb
J cfhY]'Y'ZØf'X]Y'A]h[`]YXgWXUZh'V]YhYh'

EiY``Y.::]bUbWJU``H]a Yg

8 Y hU1`c

6 Y gi W Y b 'G]Y 'i b g 'Ui Z '_fmd hc!b Y k g "Uh