

J K 'Ybh[Y\h'Xi fW\ 'DUbbY'(ž' 'A]``]cbYb 9i fc'6i » [Y`X']a '8]YgY`g_UbXU`°

J c`_gk U[Yb Ybh[Y\h'Y]bYa '6i » [Y`X'j cb '(ž 'A]``]cbYb'9i fc
 k Y[Yb '8 UhYbgWki hnZY\`Yf']a '8]YgY`g_UbXU`"'9]b
 ; Yf]Wkhgi fhY]``ghY\h'Ui g"



6UX ?]gg]b[Ybž8Yi hgWX`UbX'!'8Yf'8]YgY`g_UbXU``\Uh
Jc`_gk U[Yb'ØVYfX]Y``YhnhYb'J\fY`\]bk Y[ghUf_'VY`UghYhži bX'X]Y

Øb[ghYb'9bhk]W_`i b[Yb'nY][Ybž'XUgg'XUg'I bhYfbY\a Yb
k Y]hYf\]b'a]h'fYW\h`]W\Yb'<YfUi gZcfXYfi b[Yb'ni '_Aa dZYb'\Uh'
5_hi Y```\Uh'XYf'Jc`_gk U[Yb!?cbnYfb'Y]bYa '6i »[Y`X'jcb'(ž'
A]``]cbYb'9i fc'Ybh[Ub[Ybž'XUg'g]W\'Ui g'8UhYbgW\i hnj YfghÒ»Yb

Yf[YVYb'\AhhY"'K]Y'A U]bdcgh'VYf]W\hYhž'k Uf'Y]bY'YbhgW\Y]XYbXY
6Y\ÒfXYž'X]Y'GhUUhgUbk U`hgW\UZh'<Ubbcj Yfž'VY]']\fYa

GW\f]Zhk YW\gY`'bUW\`Agg]['i bX'\UhhY'j Yf[YggYbž'Y]bYb'k]W\h][Yb

GW\f]ZhgUhn'ni 'i bhYfgW\fY]VYb"'8]YgY'DUbbY'ZØ\fhY'XUni ž'XUgg'XUg
I bhYfbY\a Yb'j cfYfgh'b]W\h'ni f'?UggY'[YVYhYb'k YfXYb'_Ubb"

 $\exists a : c_i g : XYf : F YW : hgghfY]h][_Y]hYb : ghY \ h : X]Y : i bni fY]WXYb XY$

♣ Zcfa Uh]cb XYf A]hUfVY]hYf ØVYf X]Y K Y]hYf[UVY]\fYf 8 UhYb Ub
@Uffm H\ca dgcb Z XYb I G!5 i ZgY\Yf 8]Y 5 i ZUfVY]hi b[XYg
8]YgY`g_Ub XU`g Z XYf]a '≯J\f &\$%) 'Ui Z[YXYW_h'k i fXY Z]gh XUa]h]b
Y]bY bY i Y 'Dfc V`Ya ghY``i b['[YfUhYb "'; Yf]Wk hY 'a i ggh Yb
Ybhg Wk Y]XYb Z c V 'J c `_gk U[Yb 'X]Y 'B Ua Yb 'j cb '& A]hUfVY]h Yfb
c\bY 'XYf Yb 'Ui gfY]Wk Yb XY '5 i Z_`Afi b['Ub 'X]Y I G!6Y\Of XYb
k Y]h Yf[YVYb 'Xi f ZhY ' 'k Ug 'Yhnh`]Wk 'Ui Wk 'HY] 'XYf 'J Yf\Ub X`i b[Yb
k Uf Z 'k]Y '< B 5 'VYf]Wk hYh"

8UhYbgWlihn]a ?fYinZYiYf

8 Ugʻl fhY]``XYgʻJ Yfk Uʻhi b[g[Yf]Wk hgʻ< Ubbcj YfʻZc`[hYʻbUWkʻa Y\f
UʻgʻgYWkgʻGhi bXYbʻJ Yf\UbX`i b[ʻi bXʻ\cVʻ\Yfj cfžʻXUggžʻk À\fYbX
X]YʻB Ua YbʻXYfʻA]hUfVY]hYfʻØVYf[YVYbʻk YfXYbʻXi fZhYbžʻXYfYb

DʻZcfa Uh]cbʻXUni ʻa Ub[Y`\UZhʻ[Yk YgYbʻk Uf"'Jcbʻ]bg[YgUa hʻZØbZ
J Yfk Ufbi b[YbžʻX]YʻXYfʻb]YXYfgÀWkg]gWkY

8 UhYbgWki hnVYUi ZhfU[hYʻ[Y[YbØVYfʻJ KʻUi g[YgdfcWkYbʻ\UhhYž
k i fXYbʻnk Y]'ni ʻ; i bghYbʻXYgʻl bhYfbY\a YbgžʻYXcWkʻXfY]ʻ[Y[Yb
X]YgYgʻYbhgWk]YXYb"ʻDgVYgcbXYfYʻXYfʻJcfk i fZžʻXUggʻb]Wkh
Ui gfY]WkYbXʻXc_i a Ybh]Yfh'k i fXYž'k]YʻX]Yʻ?ca a i b]_Uh]cbʻa]h
XYbʻ9D5!DfØZYfbʻUV`]YZžʻk i fXYʻVYqhÀf_h'

8]Y'78I!: fU_h]cb']a '@UbXhU['\Uh'X]Y'5b[Y`Y[Yb\Y]h'U`g'G_UbXU`VYnY]W\bYh'i bX'd`Ubh'Y]bY'8]g_i gg]cb']a 'FYW\hgUi ggW\i gg"'9]b GdfYW\Yf'XYf'GhUUhgUbk U`hgW\UZh'VYnY]W\bYhY'X]Y'G]hi Uh]cb'U`g 9]bnY`ZU``ž'XYf'Xi fW\i b[`ØW_`]W\Y'I a ghÀbXY'i bX'\c\Y 5fVY]hgVY`Ughi b['j Yfi fgUW\h'k i fXY"'8YbbcW\'V`Y]Vh'UVni k UfhYbž k]Y'J K 'Ui Z'X]Y'bUW\'k]Y'j cf'[Y`hYbXYb 8UhYbqW\i hnUbZcfXYfi b[Yb'fYU[]YfYb'k]fX"

9]b 'V'i h][Yf'G_UbXU'

8 Yf 8]YgY `g_Ub XU``j cb 'J c`_gk U[Yb `\ Uh `X Ug`l bhYfbY\a Yb `gY]h &\$%) ']b 'XYb '6 Ubb '[Ync[Yb 'i b X 'X]Y 'fYW\h`]W\ Yb '? cbgYei YbnYb gi a a]YfYb 'g]W\ 'Ui Z'VYY]b Xfi W_Yb XY '' & 'A]``]Uf XYb '9i fc "'8]Y 5 gd Y_hY 'XYg '8 UhYbgW\ i hnYgž 'X]Y 'bi b 'j Yfa Y\fh']b 'XYb ': c_i g fØW_Yb ž'_ObbhYb 'J K ']b 'XYf 'k Y]hYfYb '5i ZUfVY]hi b['Yf\YV`]W\Yb ? cd ZnYfVfYW\Yb 'VYfY]hYb "'8]Y 'VYZUgghYb'; Yf]W\hY 'g]b X 'g]W\ 'Y]b][ž

XUggʻJ Kʻnk UfʻhY]`k Y]gYʻF YW\h'Yf\U`hYbʻ\UhžʻYXcW\'b]W\h']a; UbnYb. '8 Yfʻ8]YgY`!G_UbXU``V`Y]Vh'b]W\h'bi fʻY]bʻZ]bUbn]Y``Ygž gcbXYfbʻUi W\'Y]bʻ'\f]gh]gW\YgʻA]bYbZY`XʻZØfʻXYb5i hca cV]`\YfghY``Yf"

K À\fYbX'XUg'I fhY]`'bcW\'b]W\h'fYW\hg_fÀZh][']gh'i bX'gck c\`'J K U`g'Ui W\'X]Y'GhUUhgUbk U`hgW\UZh'XUfØVYf'bUW\XYb_Ybž'k]Y'g]Y k Y]hYf'j YfZU\fYb'a ØggYbž'V`Y]Vh'X]Y'ÒZZYbh`]W\Y'K U\fbY\a i b[XYg'I bhYfbY\a Ybg'Ui Z'XYa 'DfØZghUbX"'8]Y'<YfUi gZcfXYfi b[Yb']bXYf'?ca a i b]_Uh]cb'i bX'XYb'8UhYbgW\i hn!Jcf[UVYb'g]bX'YhnhU_hi Y``Yb'i bX'_ca a YbXYb'<YfUi gZcfXYfi b[Ybž'a]h'XYbYb Jc`_gk U[Yb'g]W\'Ui gY]bUbXYfgYhnYb'a i gg"

 $\pm 0.12]YgYfG]hiUh]cb.ghY.hg]WX.X]Y.fU[Y.K]Y.k]fX.JK.]b.Ni_ibZhX]Y.8UhYbgWXihnVYgh]a aib[Yb.Y]b\U.hYb.ibX.[.Y]WXnY]h][.XUgJYfhfUiYb.gY]bYfA]hUfVY]hYfibX.?ibXYb.nifØW_[Yk]bbYb3.9]b [ihYg.<a href="https://doi.org/10.1116/jww.ny.jhyfibx.ny.jhy$

8 YhU]`g	
Cfh	6UX:?]gg]b[Ybž8Yi hgWX`UbX
EiY``Yb	• k k k "a U]bdcgh"XY
	• k k k "\bU"XY

6 Y gi W Y b 'G | Y 'i b g 'U i Z 'b U [! V U m Y f b " X Y