

ARTS2485

9|d`cf]b[': fYbW\'@]b[i]gh]Wg

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

7ci fgY⁻Cj Yfj]Yk

GHJZ7cbHJWh8YHJ]`g

7cbj Ybcfg

B Ua Y	9a U]`	5j U]`UV]`] m	@cWUh]cb	D\cbY
<i[i dyhyfg<="" td="" yg=""><td>\"dYhYfg4 i bgk "YXi "Ui</td><td>Cb`]bYž'Vm Uddc]bha Ybh</td><td>A 6 &+)</td><td>\$& - ' ,) %((\$ '# - \$*) '- ++)</td></i[i>	\"dYhYfg4 i bgk "YXi "Ui	Cb`]bYž'Vm Uddc]bha Ybh	A 6 &+)	\$& - ' ,) %((\$ '# - \$*) '- ++)

GWXcc``7cbHJWhi±bZcfa Uh]cb

 $\label{eq:GWCC} $$GW\cc``cZ<iaUb]$$fYg'UbX'@Ub[iU[Yg]$$$

@cWUhjcb. GWkcc CZJWY ZA cfj Yb 6fck b 6i] X]b[z @Yj Y 8 & Z &),

CdYb]b['< ci fg. 'A cbXUm! ': f]XUmž'- Ua '!') da

D\cbY. 'Ž*%'&'-',)'%*,%

: UI . Ž*%'&'-' ,) ', +\$)

9a U]`. \<u>U`4 i bgk "YXi "Ui</u>

7ci fgY 8YHJ] g

7 fYX]hDc]bhg * *

Gi a a UfmcZh\Y 7ci fgY

H\]g`Wci fgY`HJi [\hi]b`9b[`]g\`cZYfg`U`gmghYa Uh]WWca dUf]gcb`cZ: fYbW\`UbX`9b[`]g\`Ug`ZJf`Ug`gci bXgž j cWJVi `Ufmžk cfX`Zcfa Uh]cbžUbX`gYbhYbW\`ghfi Wf fY`UfY`WcbW\fbYX\"=fk]``ZcW g`cb`h\Y`hmd]\WJ``X]ZZ]\W``h]Yg YbWci bhYfYX`Vm`YUfbYfg`cZ: fYbW\`]b`dfcbi b\\JUh]cbž'cfh\c[fUd\mž'UbX`[fUa a Uf`]b`cfXYf`hc`[]j Y`h\Ya 'h\Y hcc`g`hc`]a dfcj Y`h\Y]f`UWW fUWhUbX`VYWca Y`]bXYdYbXYbh`YUfbYfg"

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

- %" 5dd`mU`Wf]h]WU`i bXYfgHUbX]b['cZh\Y'hcc`g`UbX'a Yh\cXg`cZ`]b[i]gh]W]bei]fm" &" 9I Ua]bY'h\Y'j Uf]ci g``]b[i]gh]WWUhY[cf]Yg`]b`: fYbW\. 'gci bXgž'a cfd\Ya Ygž'k cfXgž'd\fUgYg`UbX WUi gYg"
- ' " 7 ca dufy j Uf]ci g`]b[i]gh]WWUhy[cf]yg']b': fYbW\"UbX'9b[`]g\"
- (" ¥Ybh]Zmgca Y ZYUhi fYg cZ`]b[i]gh]WX]j Yfg]hm"

HYUWX]b['GhfUhY[]Yg'

FUNCbUY.

H\]g`Wci fgY`dfcj]XYg`Ub`]blfcXi Wfjcb`hc`h\Y`ghfi Wi fY`cZh\Y`: fYbW\``Ub[i U[Y`UbX`k]```ZcW g`cb`h\Y`hmd]WU`X]ZZ]W``hJYg`YbWci bhYfYX`Vm9b[`]g\!gdYU_]b[```YUfbYfg`cZ: fYbW\"`5```cZci f`ghi XYbhg`\Uj Y`9b[`]g\`Ug`cbY cZh\Y]f``Ub[i U[Yg`Ug`UbUh]j Y`cf`U`gYWcbX``Ub[i U[Y"`Gc`WcbhfUgh]b[`h\Y`h\ c`a U_Yg`gYbgY"`K Y`k]```U`gc []j Y`h\Y`cddcfhi b]hmZcf`ghi XYbhg`k\cgY`Z]fgh``Ub[i U[Y`]g`bch'9b[`]g\`hc`a U_Y`di bWfi U``Wca dUf]gcb`k]h\ h\Y]f`Z]fgh``Ub[i U[Y`]b`Ub`cfU``[fUa a Uf`dfYgYbhUh]cb"

 $H\g`WcbhYl\ ii\ U``ghi\ X]Yg`Wci\ fgY`]g`]bhY[\ fUhYX`k\]h\]b``h\Y`:\ fYbW\ghi\ X]Yg`dfc[\ fUa\ \check{z}'Ug`]hiVi\]`Xg`cb`h\Y`YUfb]b[\ `cZh\Y`ghfi\ Wi\ fYg`X]gWcj\YfYX`]b``Ub[\ i\ U[\ Y`Wci\ fgYg\check{z}'UbX`Wca\ d`Ya\ Ybhg`ch\Yf``]b[\ i\]ghJ\W``m$

5ggYgga Ybh

 $: YYXVUW_`cb`UggYgga~Ybhbcfa~U``m'hU_Yg`'\%$`k~cf_]b[~XUmg"$

5ggYgga Ybh HUg_g

5ggYgga Ybh'HJg_	K Y][\h	8i Y'8UHY	Gh XYbh@YUfb]b[Ci hWca Ygʻ5ggYggYX
HYgh) \$1	8 i f]b[``YWni fY. f]Ł >i bY &&ž &\$&%fk YY_ (Ł/f]]Ł >i `m% ž &\$&%fk YY_ +Ł	%ž &
Dfc YWi) \$1	f]LH\Y [fci d cfU`dYgYbhUh]cb]g Xi Y Vm>i `m&* ž&\$&%Uh) da fk YY Ł/f]]Lh\Y]bX]j]Xi U`k f]hYb fYdcfh]gXi Y Xi f]b[h\Y YI Ua]bUh]cbdYf]cX. cb 5i [i gh%* ž&\$&%Vm) da "	' Ĭ(

5ggYgga Ybh'8YHJ]`g

5ggYgga Ybh'% 'HYgh

 $\textbf{GhUfhXUhY}. \ \texttt{Bch5dd`]} \textbf{WUV`Y}$

@Yb[h\."WU"") \$ a]b""YUW\

8YHJ]`g.

 $\label{thm:continuous} Hk\ c\]b!\ WUgg\ Hy\ ghg\ cZWU"')\ \$'a\]bi\ Hy\ g'YUWX\ Wcj\ Yf]b[\ 'h\ Y'Wcbhy bhcZh\ Y'Wci\ fgY'j\]U'dfcV'Ya\ 'gYhg'UbX'g\ cfh\ YggUmei\ Ygh]cbg"' H\ Y'gi\ a\ a\ Uhjj\ Y'hy\ ghg'UfY'dfYWYXYX'Vm\ Zcfa\ Uhjj\ Y'k\ YY_`mcb`]bY'UbX\ f'hi\ hcf]U``YI\ YfW]gYg''$

 $: YYXVUW\underline{\ 'j}\]U']b!WUgg'X]gW'gg]cb\check{z}'Yffcf'WcffYWf]cb\check{z}'UbX'k\ f]hhYb'Wca\ a\ Ybhg''$

5XX]h]cbU`XYhJ]`g.

H\Y'hYgh'k]``VY'WcbXi WhYX'cb`]bY"

Hi fb]hjb gYhjb[. H\]g]g bchU Hi fb]hjb Ugg][

‰

ghti Whi tyth ymk Ubhihc yb \UbW"

5 hmy b X Ub WY F Yei] f Ya Yb hg

5 HY b X U b W 'c Z Hi hcf] U 'g ']g 'a U b X U hcfm']b 'h]g 'Wci fgY'' 5 HY b X U b W 'hc 'gmb W fobci g 'Y Wi fYg ']g 'gffcb[`m Y b Wci fU [Y X 'U b X 'ghi X Y b hg 'U fY 'f Y ei Ygh Y X 'hc 'f Y j]Y k 'Y Wi fY 'f Y Wcf X] b [g 'Zcf' W U gg Y g 'a]gg Y X "'I b Y I W g Y X U V g Y b W 'Z ca 'a cfY 'h U b '&\$ I 'c Z Hi hcf] U 'g 'k] ``f Y gi 'h]b 'h Y 'U k U f X 'U 'Z J] ``[f U X Y " +b 'Y Y Wi f Y g 'U b X 'h hcf] U 'g mci 'k] `` U W j Y `m Y b [U [Y 'k]h 'Wcf Y 'Wci fg Y 'Wc b h Y b hz Y b U V '] b ['n ci 'hc 'U h U] b '7 @ C % U b X '7 @ C & "5 h h Y b X U b W k] ``f Y gi 'h]b 'U 'f Y Wcf X Y X 'U fh Y Z J Wh Z c f' d U fh W d U h j c b 'a U m] b Wi X Y 'U 'd c g hz c f' f Y g d c b g Y 'hc 'U b 'c b `] b Y X] g W gg] c b 'Z c fi a z'd c ``c f' ei] n z' k \] 'Y 'U b 'U fh Y Z J Wh Z c f' a U b X U hc fm U hh Y b X U b W 'a U m] b Wi X Y 'U 'f Y Wc f X 'c Z U t h Y b X U b W 'E"

7 ci fgY GWX YXi `Y

J]Yk 'WUgg'ha YHJV'Y

H]a YtUV`Y

8UhY	HmdY	7 cbh/bh
K YY_'%'' %A Um!'('>i bY		#BIFCXI WIJCb hc h\Y ``UmldYfgcbfg'j Yfgi g``]b[i]ghgfi UddfcUW\ hc ``Ub[i U[Y 9I d`cf]b[h\Y': fYbW\ ``Ub[i U[Y. '7 \UdhYfg'%/ '&" GhYfYchmdYg'UVci hh\Y': fYbW\ ``Ub[i U[Yž dfYgWf]dh]j]ga 'j Yfgi g'XYgWf]dh]j]ga ž'Zcfa U`'j Yfgi g]bZcfa U`'ghm`Yg GYa]bUf'YI YfWJgYg



FYgci fWyg

DfYgWf]VYX F Ygci fWyg

- @cX[Y'5"'WfS'''f&\$\$' '0%-+@"'7jb'ad\'YfZW8dWUZ>S`YgSYW'@cbXcbž'5fbc`X"
- 5XX]h]cbU`a UhYf]U`gʻdfcj]XYX`j]U`A ccX`Y"

FYWca a YbXYX FYgci fW/g

K Y 'UXj]gY 'mci 'hc'di fWkUgY 'Y]h\Yf'cbY 'cZh\Y 'Zc``ck]b['[fUa a Uf'fYZYfYbWY 'Vcc_g'k f]hhYb']b'9b[`]g\.

- A cfrcb'>"'f&\$\$- \text{L"'7} Y \(\)eZ 9 \(\text{cS} _ _ \) Sd \(\)ad E fgVW fe a X8dW UZ"'H\Y'C' \(\)j]U'UbX' <]\(\)''DfYgg"
- A WB UV F "'f&\$%* L"'8dW UZ YdS_ _ Sd_ SVWWSek" F ci hYX[Y"

H\YgY`Vcc_g`[]jY`WYUf`YId`UbUhJcbg`]b`9b[`]g\`UVci h: fYbW\`[fUa a Uf`ghUfh]b[`Zfca 'h\Y`Yj Y``cZUVgc`i hY VY[]bbYfg"'⊋mci 'UfY`Uh'U'a cfY`UXj UbW\X``Yj Y`žmci 'a Umk Ubhhc'i gY`U'a cfY`UXj UbW\X`fYZ\fYbW\ [fUa a Uf`fbYY`hYIhVcc_g`fYWca a YbXYX`]b`mci f': fYbW\``Ub[i U[Y`Wci fgYgŁ"

5XX]h]cbU``mžmci 'g\ci `X`h\]b_'UVci hUWei]f]b['U'[ccX`X]Wh]cbUfm'' \(\frac{1}{2}mci ']bhYbX`hc 'Xc'U'a U'cf']b': fYbW\žk Y fYWca a YbX`h\Uhmci 'Vi m'U``Uf[Y`V]`]b[i U``fl fYbW\!9b[`]g\#9b[`]g\!: fYbW\!X]Wh]cbUfm'' \(\frac{1}{2}mci ']bhYbX`hc 'Xc'U'a U'cf']b': YV\! m h\Y`V][[YghX]Wh]cbUfmmci 'WUb'U\ZcfX.'U'dc\W_Yhg]nY`cf'Wcb\W]gY`X]\Wh]cbUfmik]```ei]\W_`mdfcj Y`]bUXYei UhY'' \(H\Y`Zc``ck]b['X]\Wh]cbUfn'yg'UfY`Uj U]`UV`Y`Zfca 'h\Y`6cc_g\cd.

- 9ggYbh]U`: fYbVX 8]Wf]cbUfm/; fUa a Uf" &bX 9X" < UfdYf#7 c``]bg"
- C | ZcfX! < UWX YHY : fYbWX 8 | WhobUfm' C | ZcfX"

Gi Va]gg]cb cZ5ggYgga YbhHUg_g

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

Image: Ybwei bhyfu'dfcv'ya k \yb'uhhya dhjb['hc'gi va]hmci f'Ugg][ba Ybhh\fci [\ 'Hi fb]h]bz'd'YUgY

Hy'Yd\cby'9| hy'fbu''Gi ddcfhcb'-',) '' ' ' %cf'Ya U]''h\Ya 'cb'Y! hy'fbu'hy'hgi ddcfh4 i bgk "YXi "Ui "''Gi ddcfh
\ci fg'UfY', .\$\$Ua '-'%\$.\$\$da 'cb'k YY_XUmg'UbX'-.\$\$Ua '-').\$\$da 'cb'k YY_YbXg'fl *) 'XUmg'U'mYUft"'=Z'mci
UfY'i bUV'Y'hc'gi va]hmci f'Ugg][ba YbhXi Y'hc'U'ZJi 'hk]h\ 'Hi fb]h]b'mci 'a UmUdd'mZcf'Ub'Y! hy'bg]cbz'Vi hmci
a i ghfYhJ]b'mci f'h]W_Yhbi a VYf'Zfca '9! hy'fbU''Gi ddcfhfU'cb['k]h\ 'Ubmch\Yf'fy'Yj UbhXcW a Ybhgthc
]bWi XY'Ug'Yj]XYbW' hc'gi ddcfhmci f'Y! hy'bg]cb'Udd']\WJh]cb"'=Zmci 'Ya U]''9! hy'fbU''Gi ddcfhmci 'k]'`
Ui hca Uh]\WJ'`mfYW']j Y'U'h]\W_Yhbi a VYfz'Vi h]Zmci 'hY'Yd\cbY'mci 'k]``bYYX'hc'gdY\WZ]\WJ'`mUg_'Zcf'cbY''
Hi fb]h]b'U'gc'dfcj]XYg'i dXUhy'g'cb'h\Y]f'gmghYa 'ghUh' g'cb'Hk]hyf''

; YbYfU`mž'UggYgga YbhiHug_g'a i ghVY'gi Va]hhYX'Y`YVWfcb]\WJ``mij]U'Y]h\Yf'Hi fb]h]b'cf'U'A ccX`Y Ugg][ba Ybh''=b']bgHJb\W'g'k \YfY'h\]g']g'bchdcgg]V`Yž']hk]```VY'gHJhYX'cb'mci f'\\circ i fgY'g'A ccX`Y'g]hY'k]h\U`hYfbUh]j Y'gi Va]gg]cb'XYHJ]`g"

cfi]bZcfa Uhjcbicbi\ckihcigi Va]hUgg][ba Ybhgicbi]bYij]UiA ccXiY.i\hdg.#gh XYbhi bgk "YXi "Ui #\ck! gi Va]hUgg][ba Ybha ccXiY

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

D`U[]Uf]ga i]gii g]b[ih\Yik cfXgicfi]XYUgicZch\YfgiUbXidfYgYbh]b[ih\Ya iUgimci fick b"i=hWJbihU_Yia Ubm Zcfa gžZfca iXYi]VYfUhYiWXYUh]b[ihciUWW]XYbhU`mWcdm]b[iZfca iUigci fWYik]h\ci hiUW_bck iYX[Ya Ybh'

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

• i bXYfgHJbX'mci f'f][\hg'UbX'fYgdcbg]V]`]h]Yg'Ug'U'gh XYbh'Uhil BGK

5 WUXYa]W + DZcfa Uhjcb

: cf'YggYbhJU`gh XYbh]bZcfa UhJcb fY`UhJb[hc.

- fYei YghgʻZcfʻYl hYbg]cb/
- `UhY 'gi Va]gg]cbg '[i]XY`]bYg/
- fYj]Yk 'cZa Uf_g/
- I BGK < YU`h\ UbX GUZYmdc`]W[Yg/
- YI Ua]bUh]cb dfcW/Xi fYg/
- gdYWJU``Wcbg]XYfUHjcb']b'H\Y'Yj YbhcZ]``bYgg'cf'a]gUXj Ybh fY/
- gh XYbhYei]hmUbX'X]gUV]`]hm/
- UbX'ch\Yf'YggYbhJU`'UWUXYa]W]bZcfa UhJcbž'gYY