

# **MAX potential observations of classical novae**

M. HERNANZ, 2004

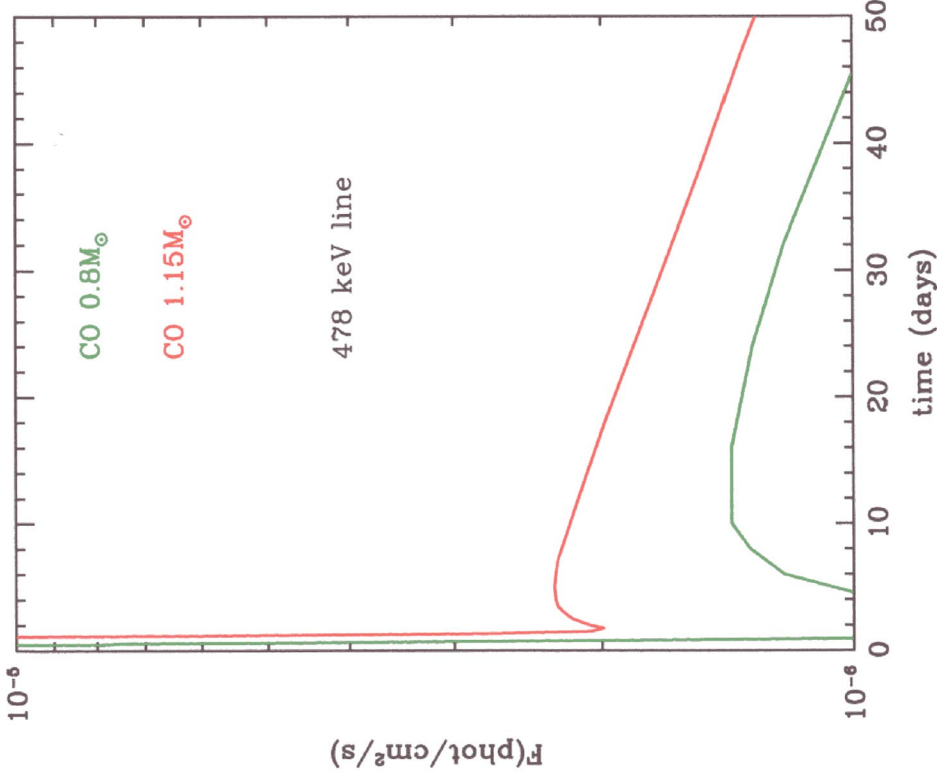
# Main radioactive isotopes synthesized in classical novae

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Nucleus	$\tau$	Type of emission	Nova type
$^{13}\text{N}$	862 s	{ 511 keV line continuum (E<511 keV)	CO and ONe
$^{18}\text{F}$	158 min	{ 511 keV line continuum (E<511 keV)	CO and ONe
$^7\text{Be}$	77 days	478 keV line	CO mainly
$^{22}\text{Na}$	3.75 yr	1275 keV line	ONe
$^{26}\text{Al}$	$1.0 \times 10^6$ yr	1809 keV line	ONe

# Light curves: 478 keV ( ${}^7\text{Be}$ ) line

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Mainly in CO novae

$t_{\text{max}}$ : 13 days (0.8M<sub>⊙</sub>)

5 days (1.15 M<sub>⊙</sub>)

duration: some weeks

Flux  $\sim (1-2) \times 10^{-6}$  ph/cm<sup>2</sup>/s

Line width: 3-7 keV

d=1 kpc

➡ predicted theoretically by Clayton 1981

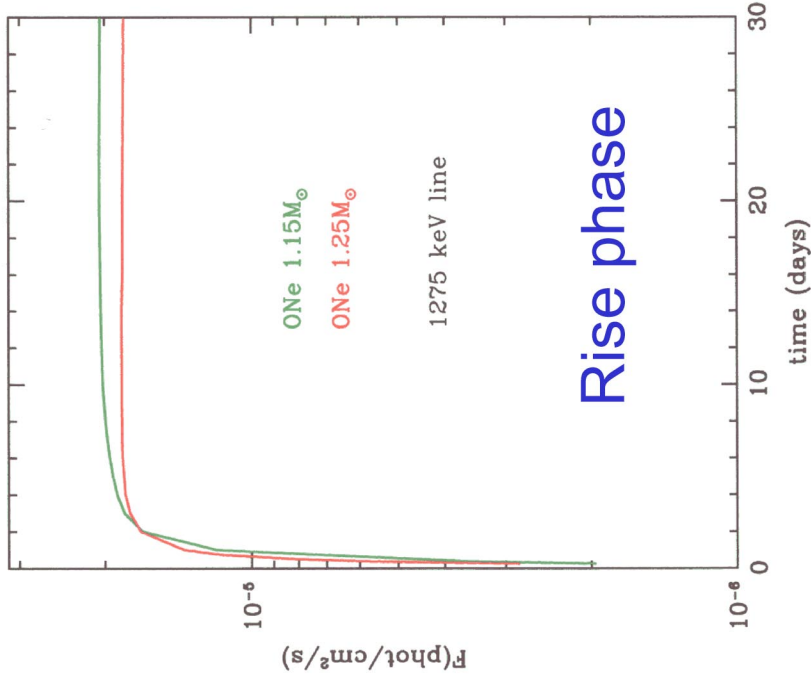
# Detectability with MAX of the 478 keV (<sup>7</sup>Be) line from novae

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- If MAX sensitivity at **478 keV** is  $\sim 3 \times 10^{-7}$  ph/cm<sup>2</sup>/s (taken from figure 4a in the MAX concept document, V2.0, 2/2003), it could detect the <sup>7</sup>Be line from novae up to **2 kpc** (ideal case of a narrow line; the **line** has a **width** between **3** and **7 keV**).
- **Number of novae** per year at  $d \leq 2$  kpc: **3 every 5 years** (small number statistics  $\Rightarrow$  large fluctuations)

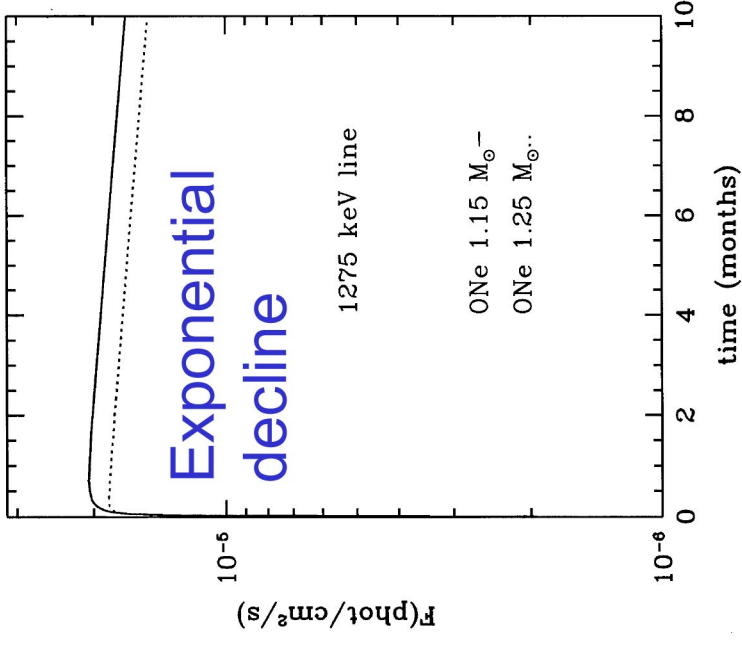
(This was already included in the science case of a previous MAX proposal)

# Light curves: 1275 keV ( $^{22}\text{Na}$ ) line



Only in  
ONE  
novae

$d=1$  kpc



$t_{\text{max}}$ : 20 days (1.15 $M_{\odot}$ ), 12 days (1.25  $M_{\odot}$ ), line width  $\sim$  20 keV

duration: some months      Flux  $\sim$   $2 \times 10^{-5}$  ph/cm $^2$ /s

$\rightarrow$  predicted theoretically by Clayton & Hoyle, 1974

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Detectability with MAX of the 1275 keV ( $^{22}\text{Na}$ ) line from novae, if there was an “extra ring” with the same sensitivity at 1275 keV that the current one at 847 keV

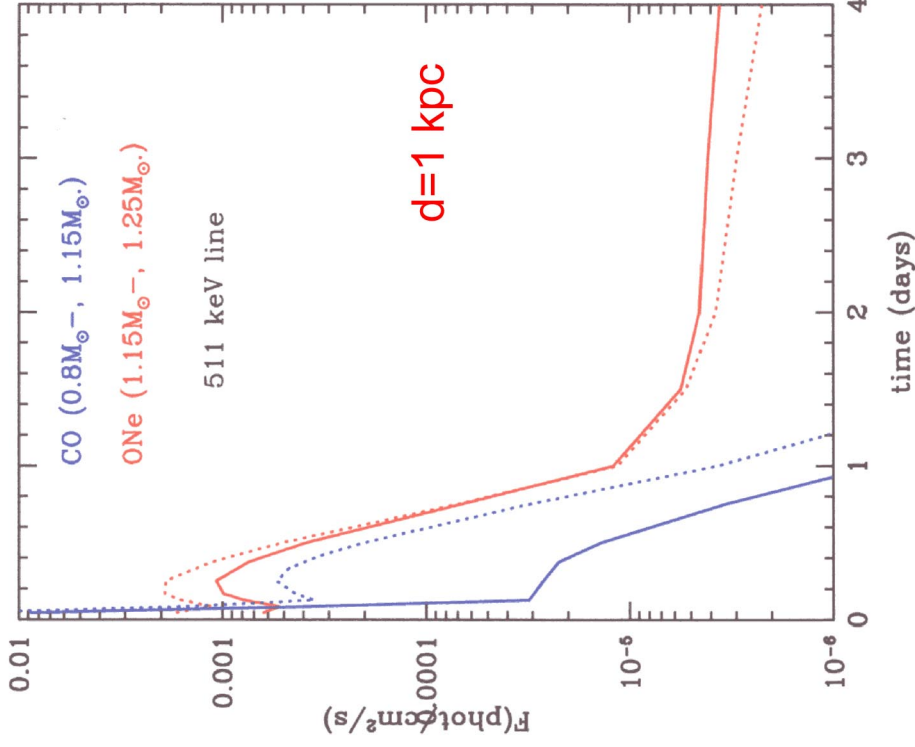
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- If MAX sensitivity at **1275 keV** were  $\sim 3\text{e-}7$  ph/cm<sup>2</sup>/s (extrapolated from figure 4b in the MAX concept document, V2.0, 2/2003), it could detect the  $^{22}\text{Na}$  line from novae up to **8 kpc** (ideal case of a narrow line; the line has a width around **20 keV**).
- Number of novae per year at  $d \leq 8$  kpc: **16 every 5 years**, i.e. virtually **all novae** (or half of them, since only ONE emit produce  $^{22}\text{Na}$ )

So it is a pity that MAX will not focus photons of 1275 keV!

# Light curves: 511 keV line

## In CO and ONe novae



Model	$t_{\max}^*$ (h)	$F_{\max}^{**}$ (ph/cm <sup>2</sup> /s)
CO, 0.8 $M_{\odot}$	---	$2.6 \times 10^{-5}$
CO, 1.15 $M_{\odot}$	6.5	$5.3 \times 10^{-4}$
ONe, 1.15 $M_{\odot}$	6	$1.0 \times 10^{-3}$
ONe, 1.25 $M_{\odot}$	5	$1.9 \times 10^{-3}$

- 511 keV line in ONe novae remains after 2 days until ~ 1 week because of  $e^+$  from  $^{22}\text{Na}$
- Intense (but short duration)
- Very early appearance, before visual maximum (i.e., before discovery)