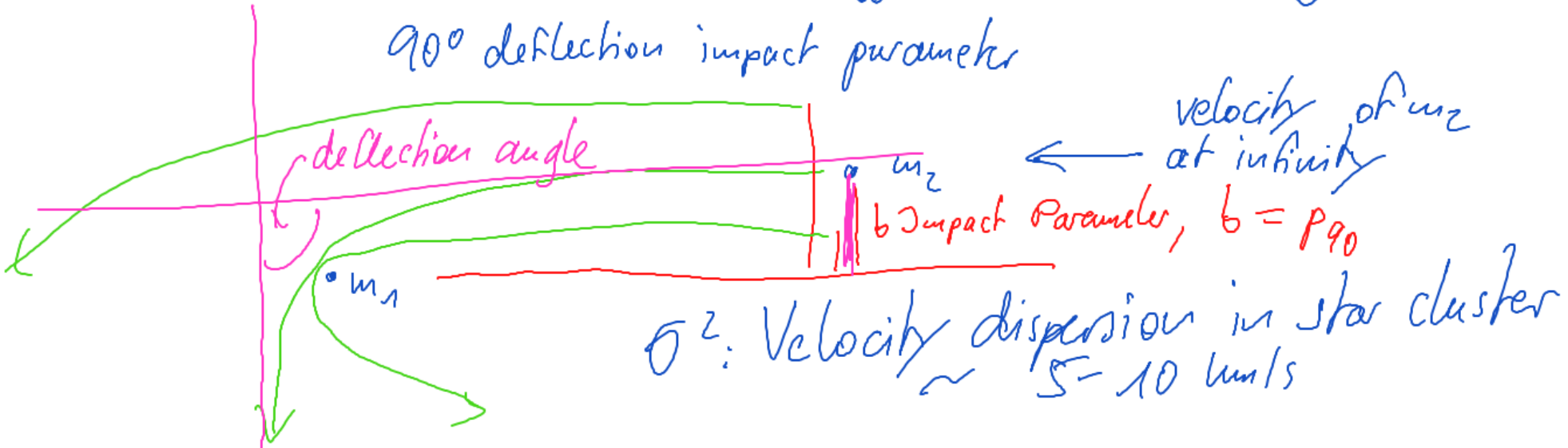
Regularizations – Decision Making
(see also NBody Manual)

- Necessary Criteria: RMIN, DTMIN

RMIN: $p_{90^\circ} = \frac{2G(m_1+m_2)}{v_\infty^2} \approx \frac{2G(m_1+m_2)}{\sigma^2}$



σ^2: Velocity dispersion in star cluster
$\sim$ 5 – 10 km/s

$$RMIN: \quad \sim \frac{2G(m_1+m_2)}{\sigma^2} \simeq \frac{4}{N}$$

$M_{tot} = 1$;
$\langle m \rangle = \frac{1}{N}$
$\langle m_1 + m_2 \rangle = \frac{2}{N}$

RMIN has to become smaller for large N, with $1/N$

$$DTMIN: \quad K \left[\frac{\eta_I}{0.03}\right] \cdot \left(\frac{RMIN^3}{G\langle m \rangle}\right)^{1/2} \simeq \sqrt{N}$$

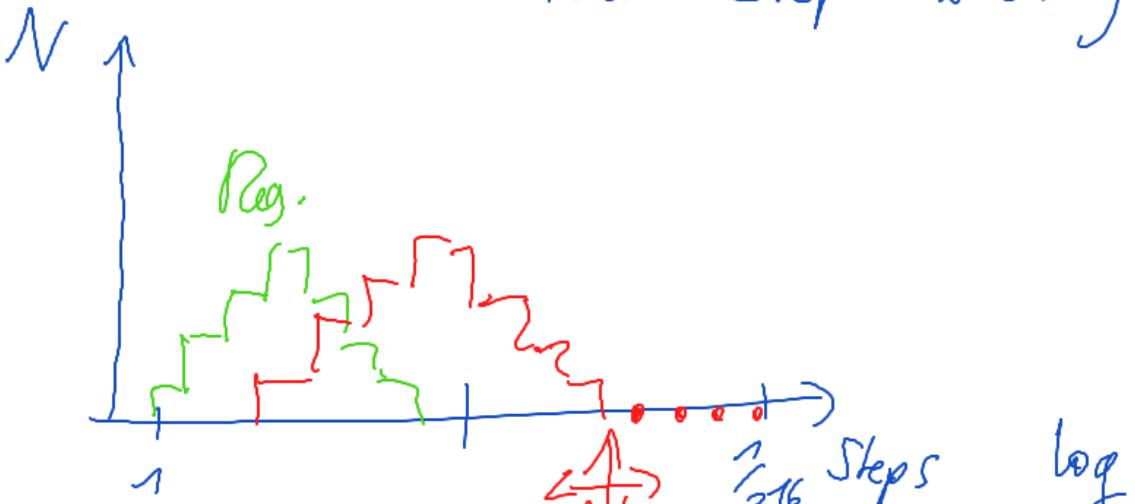
$K \simeq 0.01$; $\eta_{in.}$: Time Step Factor ETAI

$\left(RMIN^3/G\langle m \rangle\right)^{1/2} \sim$ time

$\langle m \rangle \sim \frac{1}{N}$:

$$DTMIN \propto \sqrt{N}$$

Remember Time Step Histograms: STEP I
STEP R



~ DTMIN, RMIN

Necessary!

Code:

1 pair at a time
(irregular step levels)

Initial Binaries: need special routines to regularize all binaries before starting

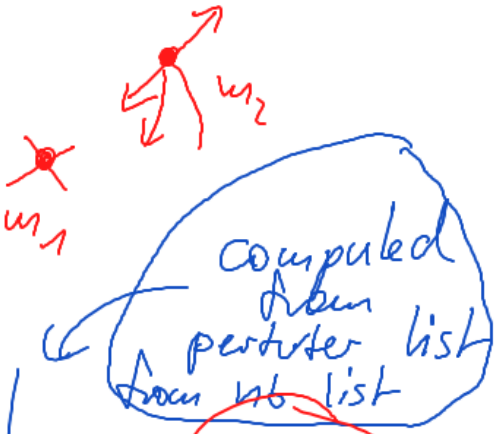
Necessary Condition:

$\vec{R} = \vec{r}_1 - \vec{r}_2$

$\vec{V} = \vec{v}_1 - \vec{v}_2$

1) $\vec{R} \cdot \vec{V} > 0.1 \sqrt{G(m_1 + m_2)/R}$

particles must approach each other!



2) Perturbation by other particles is less than 25%

$$\gamma = \frac{|\vec{a}_{pert}| R^2}{G(m_1 + m_2)} = \frac{|\vec{a}_{pert}|}{|\vec{a}_{2body}|} < 0.25$$

- Necessary + Suff. Criteria to start regularization
- Termination:

$$GMIN \sim \gamma_{min} \sim 10^{-6} \quad ; \quad \gamma = \frac{|\vec{a}_{pert}|}{|\vec{a}_{2body}|} < 10^{-6}_{GMIN}$$

terminate? → unperturbed two-body problem → analytically

$r_{min} = a(1-e)$

→ but check for collisions

Stellar Evolution: r_{*1}, r_{*2}

Only if $r_{min} > \frac{3}{4}(r_{*1} + r_{*2})$

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