First model-independent results from DAMA/LIBRA–phase2
**DAMA set-ups**

an observatory for rare processes @ LNGS

![Diagram of DAMA set-ups]

**Collaboration:**

Roma Tor Vergata, Roma La Sapienza, LNGS, IHEP/Beijing
+ by-products and small scale expts.: INR-Kiev + other institutions
+ neutron meas.: ENEA-Frascati, ENEA-Casaccia
+ in some studies on $\beta\beta$ decays (DST-MAE and Inter-Universities project):
  IIT Kharagpur and Ropar, India

[web site: http://people.roma2.infn.it/dama]
Relic DM particles from primordial Universe

DM direct detection method using a model independent approach and a low-background widely-sensitive target material

What accelerators can do:
to demonstrate the existence of some of the possible DM candidates

What accelerators cannot do:
to credit that a certain particle is the Dark Matter solution or the “single” Dark Matter particle solution...

+ DM candidates and scenarios exist (even for neutralino candidate) on which accelerators cannot give any information
Some direct detection processes:

- Scatterings on nuclei
  \[ W + N \rightarrow W^* + N \]
  → detection of nuclear recoil energy

- Excitation of bound electrons in scatterings on nuclei
  → detection of recoil nuclei + e.m. radiation

- Conversion of particle into e.m. radiation
  → detection of \( \gamma \), X-rays, e-

- Interaction only on atomic electrons
  → detection of e.m. radiation
  \( ... \) even WIMPs

- Interaction of light DMp (LDM) on e- or nucleus with production of a lighter particle
  → detection of electron/nucleus recoil energy
  e.g. sterile \( \nu \)

- Inelastic Dark Matter:
  \[ \frac{1}{2} \mu v^2 \geq \delta \iff v \geq v_{\text{thr}} = \sqrt{\frac{2\delta}{\mu}} \]

  \( W \) has 2 mass states \( \chi^+ \), \( \chi^- \) with \( \delta \) mass splitting

  → Kinematical constraint for the inelastic scattering of \( \chi^- \) on a nucleus

  e.g. signals from these candidates are completely lost in experiments based on “rejection procedures” of the e.m. component of their rate
The annual modulation: a model independent signature for the investigation of DM particles component in the galactic halo

With the present technology, the annual modulation is the main model independent signature for the DM signal. Although the modulation effect is expected to be relatively small a suitable large-mass, low-radioactive set-up with an efficient control of the running conditions can point out its presence.

**Requirements:**

1) Modulated rate according cosine
2) In low energy range
3) With a proper period (1 year)
4) With proper phase (about 2 June)
5) Just for single hit events in a multi-detector set-up
6) With modulation amplitude in the region of maximal sensitivity must be <7% for usually adopted halo distributions, but it can be larger in case of some possible scenarios

\[ v_\oplus(t) = v_{\text{sun}} + v_{\text{orb}} \cos \gamma \cos[\omega(t-t_0)] \]

\[ S_k[\eta(t)] = \int \frac{dR}{dE_R} dE_R \equiv S_{0,k} + S_{m,k} \cos[\omega(t-t_0)] \]

The annual modulation has a different origin and peculiarities (e.g. the phase) than those effects correlated with the seasons

To mimic this signature, spurious effects and side reactions must not only - obviously - be able to account for the whole observed modulation amplitude, but also to satisfy contemporaneously all the requirements

Drukier, Freese, Spergel PRD86; Freese et al. PRD88

- \[ v_{\text{sun}} \approx 232 \, \text{km/s} \] (Sun vel in the halo)
- \[ v_{\text{orb}} = 30 \, \text{km/s} \] (Earth vel around the Sun)
- \[ \gamma = \pi/3, \omega = 2\pi/T, T = 1 \, \text{year} \]
- \[ t_0 = 2^{nd} \text{June} \] (when \( v_\oplus \) is maximum)
The pioneer DAMA/Nal: ≈100 kg highly radiopure NaI(Tl)

Performances:


Results on rare processes:

- Possible Pauli exclusion principle violation: PLB408(1997)439
- CNC processes: PRC60(1999)065501
- Search for solar axions: PLB515(2001)6
- Exotic Matter search: EPJDirect C14(2002)1
- Search for superdense nuclear matter: EPJA23(2005)7
- Search for heavy clusters decays: EPJA24(2005)51

Results on DM particles:

- PSD: PLB389(1996)757

Model independent evidence of a particle DM component in the galactic halo at 6.3σ C.L.

total exposure (7 annual cycles)  0.29 ton·yr
The pioneer DAMA/Nal:
~100 kg highly radiopure NaI(Tl)

Results:
- Possible DM signals
- Exotic: EPJC72(2012)1920
- Anomalous: EPJA49(2013)64

The DAMA/LIBRA set-up ~250 kg NaI(Tl)
(Large sodium Iodide Bulk for RARe processes)

As a result of a 2nd generation R&D for more radiopure NaI(Tl) by exploiting new chemical/physical radiopurification techniques (all operations involving - including photos - in HP Nitrogen atmosphere)

- Radiopurity, performances, procedures, etc.: NIMA592(2008)297, JINST 7 (2012) 03009
- Results on DM particles:
- Results on rare processes:
  - CNC: EPJC72(2012)1920;
  - IPP in $^{241}$Am: EPJA49(2013)64

Residual contaminations in the new DAMA/LIBRA NaI(Tl) detectors: $^{232}$Th, $^{238}$U and $^{40}$K at level of $10^{-12}$ g/g

DAMA/LIBRA–phase1 (7 annual cycles, 1.04 ton×yr) confirmed the model-independent evidence of DM: reaching 9.3σ C.L.
Upgrade on Nov/Dec 2010: all PMTs replaced with new ones of higher Q.E.

Q.E. of the new PMTs:
- 33 - 39% @ 420 nm
- 36 - 44% @ peak
DAMA/LIBRA–phase2

Lowering software energy threshold below 2 keV:

- to study the nature of the particles and features of astrophysical, nuclear and particle physics aspects, and to investigate 2nd order effects
- special data taking for other rare processes

The light responses:

- DAMA/LIBRA-phase1: 5.5 – 7.5 ph.e./keV
- DAMA/LIBRA-phase2: 6-10 ph.e./keV
DAMA/LIBRA-phase2 data taking

Second upgrade at end of 2010: all PMTs replaced with new ones of higher Q.E.

Energy resolution @ 60 keV mean value:

<table>
<thead>
<tr>
<th>Annual Cycles</th>
<th>Period</th>
<th>Mass (kg)</th>
<th>Exposure</th>
<th>((\alpha-\beta^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Dec 23, 2010 - Sept. 9, 2011</td>
<td></td>
<td>commissioning</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Nov. 2, 2011 - Sept. 11, 2012</td>
<td>242.5</td>
<td>62917</td>
<td>0.519</td>
</tr>
<tr>
<td>III</td>
<td>Oct. 8, 2012 - Sept. 2, 2013</td>
<td>242.5</td>
<td>60586</td>
<td>0.534</td>
</tr>
<tr>
<td>IV</td>
<td>Sept. 8, 2013 - Sept. 1, 2014</td>
<td>242.5</td>
<td>73792</td>
<td>0.479</td>
</tr>
<tr>
<td>V</td>
<td>Sept. 1, 2014 - Sept. 9, 2015</td>
<td>242.5</td>
<td>71180</td>
<td>0.486</td>
</tr>
<tr>
<td>VI</td>
<td>Sept. 10, 2015 - Aug. 24, 2016</td>
<td>242.5</td>
<td>67527</td>
<td>0.522</td>
</tr>
<tr>
<td>VII</td>
<td>Sept. 7, 2016 - Sept. 25, 2017</td>
<td>242.5</td>
<td>75135</td>
<td>0.480</td>
</tr>
</tbody>
</table>

Fall 2012: new preamplifiers installed + special trigger modules.

Calibrations 6 a.c.: \(\approx 1.3 \times 10^8\) events from sources

Acceptance window eff. 6 a.c.: \(\approx 3.4 \times 10^6\) events (\(\approx 1.4 \times 10^5\) events/keV)

Exposure first data release of DAMA/LIBRA-phase2: 1.13 ton × yr
Exposure DAMA/NaI+DAMA/LIBRA-phase1+phase2: 2.46 ton × yr
The data of DAMA/LIBRA-phase2 favor the presence of a modulated behavior with proper features at 9.5σ C.L.
Absence of modulation? No

- **2-6 keV**: $\chi^2/dof = 199.3/102 \implies P(A=0) = 2.9 \times 10^{-8}$

**DM model-independent Annual Modulation Result**

The data of DAMA/LIBRA-phase1 + DAMA/LIBRA-phase2 favor the presence of a modulated behavior with proper features at 11.9 $\sigma$ C.L.
Releasing period ($T$) and phase ($t_0$) in the fit

<table>
<thead>
<tr>
<th></th>
<th>$\Delta E$</th>
<th>$A$(cpd/kg/keV)</th>
<th>$T=\frac{2\pi}{\omega}$ (yr)</th>
<th>$t_0$ (day)</th>
<th>C.L.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAMA/LIBRA-ph2</td>
<td>(1-3) keV</td>
<td>0.0184±0.0023</td>
<td>1.0000±0.0010</td>
<td>153±7</td>
<td>8.0$\sigma$</td>
</tr>
<tr>
<td></td>
<td>(1-6) keV</td>
<td>0.0106±0.0011</td>
<td>0.9993±0.0008</td>
<td>148±6</td>
<td>9.6$\sigma$</td>
</tr>
<tr>
<td></td>
<td>(2-6) keV</td>
<td>0.0096±0.0011</td>
<td>0.9989±0.0010</td>
<td>145±7</td>
<td>8.7$\sigma$</td>
</tr>
<tr>
<td>DAMA/LIBRA-ph1 +</td>
<td>(2-6) keV</td>
<td>0.0096±0.0008</td>
<td>0.9987±0.0008</td>
<td>145±5</td>
<td>12.0$\sigma$</td>
</tr>
<tr>
<td>DAMA/LIBRA-ph2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAMA/NaI +</td>
<td>(2-6) keV</td>
<td>0.0103±0.0008</td>
<td>0.9987±0.0008</td>
<td>145±5</td>
<td>12.9$\sigma$</td>
</tr>
<tr>
<td>DAMA/LIBRA-ph1 +</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAMA/LIBRA-ph2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$A_{\cos[\omega(t-t_0)]}$

DAMA/NaI (0.29 ton x yr)
DAMA/LIBRA-ph1 (1.04 ton x yr)
DAMA/LIBRA-ph2 (1.13 ton x yr)

total exposure = 2.46 ton$\times$yr
Rate behaviour above 6 keV

- No Modulation above 6 keV

 damages/keV

<table>
<thead>
<tr>
<th>Period</th>
<th>Mod. Ampl.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAMA/LIBRA-ph2_2</td>
<td>(0.12±0.14) cpd/kg</td>
</tr>
<tr>
<td>DAMA/LIBRA-ph2_3</td>
<td>-(0.08±0.14) cpd/kg</td>
</tr>
<tr>
<td>DAMA/LIBRA-ph2_4</td>
<td>(0.07±0.15) cpd/kg</td>
</tr>
<tr>
<td>DAMA/LIBRA-ph2_5</td>
<td>-(0.05±0.14) cpd/kg</td>
</tr>
<tr>
<td>DAMA/LIBRA-ph2_6</td>
<td>(0.03±0.13) cpd/kg</td>
</tr>
<tr>
<td>DAMA/LIBRA-ph2_7</td>
<td>-(0.09±0.14) cpd/kg</td>
</tr>
</tbody>
</table>

σ ≈ 1%, fully accounted by statistical considerations

- No modulation in the whole energy spectrum:
  studying integral rate at higher energy, R₉₀
  - R₉₀ percentage variations with respect to their mean values for single crystal in the DAMA/LIBRA running periods
  - Fitting the behaviour with time, adding a term modulated with period and phase as expected for DM particles:
    consistent with zero
  + if a modulation present in the whole energy spectrum at the level found in the lowest energy region → R₉₀ ~ tens cpd/kg → ~ 100 σ far away

This accounts for all sources of bckg and is consistent with the studies on the various components
DM model-independent Annual Modulation Result
DAMA/LIBRA-phase2 (1.13 ton × yr)

Multiple hits events = Dark Matter particle “switched off”

Single hit residual rate (red) vs Multiple hit residual rate (green)

• Clear modulation in the single hit events;
• No modulation in the residual rate of the multiple hit events

This result offers an additional strong support for the presence of DM particles in the galactic halo further excluding any side effect either from hardware or from software procedures or from background.
The analysis in frequency

To perform the Fourier analysis of the data in a wide region of frequency, the single-hit scintillation events have been grouped in 1 day bins.

The whole power spectra up to the Nyquist frequency:

- **DAMA/NaI + DAMA/LIBRA-(ph1+ph2) (20 yr)**
  - Total exposure: 2.46 ton×yr

Zoom around the 1 yr⁻¹ peak:

- **Principal mode:**
  - $2.74 \times 10^{-3}$ d⁻¹ ≈ 1 yr⁻¹

Green area: 90% C.L. region calculated taking into account the signal in (2-6) keV.

Clear annual modulation in (2-6) keV + only aliasing peaks far from signal region.
Energy distribution of the modulation amplitudes

Max-likelihood analysis

\[ R(t) = S_0 + S_m \cos \left[ \omega \left( t - t_0 \right) \right] \]

here \( T = 2\pi / \omega = 1 \text{ yr} \) and \( t_0 = 152.5 \text{ day} \)

The two \( S_m \) energy distributions obtained in DAMA/NaI+DAMA/LIBRA-ph1 and in DAMA/LIBRA-ph2 are consistent in the (2–20) keV energy interval:

\[ \chi^2 = \sum \frac{(r_1 - r_2)^2}{\sigma_1^2 + \sigma_2^2} \]

(2-20) keV \quad \chi^2 / \text{d.o.f.} = 32.7/36 \quad (P=63%) 

(2-6) keV \quad \chi^2 / \text{d.o.f.} = 10.7/8 \quad (P=22%)
A clear modulation is present in the (1-6) keV energy interval, while $S_m$ values compatible with zero are present just above.

- The $S_m$ values in the (6–14) keV energy interval have random fluctuations around zero with $\chi^2$ equal to 19.0 for 16 degrees of freedom (upper tail probability 27%).
- In (6–20) keV $\chi^2$/dof = 42.6/28 (upper tail probability 4%). The obtained $\chi^2$ value is rather large due mainly to two data points, whose centroids are at 16.75 and 18.25 keV, far away from the (1–6) keV energy interval. The P-values obtained by excluding only the first and either the points are 11% and 25%.

Max-likelihood analysis

$$R(t) = S_0 + S_m \cos \left[ \omega (t - t_0) \right]$$

Here $T = 2\pi/\omega = 1$ yr and $t_0 = 152.5$ day
The signal is well distributed over all the annual cycles in each energy bin.
$S_m$ for each detector

$S_m$ integrated in the range (2 - 6) keV for each of the 25 detectors (1σ error)

Shaded band = weighted averaged $S_m \pm 1\sigma$

$\chi^2$/dof = 23.9/24 d.o.f.

The signal is well distributed over all the 25 detectors.

DAMA/LIBRA-phase1 + DAMA/LIBRA-phase2
total exposure: 2.17 ton\text{yr}
Is there a sinusoidal contribution in the signal? Phase ≠ 152.5 day?

\[ R(t) = S_0 + S_m \cos[\omega(t - t_0)] + Z_m \sin[\omega(t - t_0)] = S_0 + Y_m \cos[\omega(t - t^*)] \]

For Dark Matter signals:
- \(|Z_m| \ll |S_m| \approx |Y_m|\)
- \(t^* \approx t_0 = 152.5d\)
- \(\omega = 2\pi/T\)
- \(T = 1\) year

Slight differences from 2\(^{nd}\) June are expected in case of contributions from non-thermalized DM components (as e.g. the SagDEG stream)

### DAMA/NaI + DAMA/LIBRA-phase1 + DAMA/LIBRA-phase2

<table>
<thead>
<tr>
<th>E (keV)</th>
<th>(S_m) (cpd/kg/keV)</th>
<th>(Z_m) (cpd/kg/keV)</th>
<th>(Y_m) (cpd/kg/keV)</th>
<th>(t^*) (day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-6</td>
<td>0.0100 ± 0.0008</td>
<td>-0.0003 ± 0.0008</td>
<td>0.0100 ± 0.0008</td>
<td>150.5 ± 5.0</td>
</tr>
<tr>
<td>6-14</td>
<td>0.0003 ± 0.0005</td>
<td>-0.0009 ± 0.0006</td>
<td>0.0010 ± 0.0013</td>
<td>undefined</td>
</tr>
</tbody>
</table>

### DAMA/LIBRA-phase2

| 1-6     | 0.0105 ± 0.0011 | 0.0009 ± 0.0010 | 0.0105 ± 0.0011 | 157.5 ± 5.0 |
$R(t) = S_0 + Y_m \cos \left( \omega (t - t^*) \right)$

For DM signals:

$|Y_m| \approx |S_m|$

$t^* \approx t_0 = 152.5d$

$\omega = 2\pi / T; \quad T = 1 \text{ year}$

Slight differences from 2nd June are expected in case of contributions from non-thermalized DM components (as the SagDEG stream)
Modulation amplitudes obtained by fitting the time behaviours of main running parameters, acquired with the production data, when including a DM-like modulation

All the measured amplitudes well compatible with zero + none can account for the observed effect
(to mimic such signature, spurious effects and side reactions must not only be able to account for the whole observed modulation amplitude, but also simultaneously satisfy all the 6 requirements)
• Contributions to the total neutron flux at LNGS;
• Counting rate in DAMA/LIBRA for single-hit events, in the (2 – 6) keV energy region induced by:
  > neutrons,
  > muons,
  > solar neutrinos.

The annual modulation of solar neutrino is due to the different Sun-Earth distance along the year; so the relative modulation amplitude is twice the eccentricity of the Earth orbit and the phase is given by the perihelion. All are negligible w.r.t. the annual modulation amplitude observed by DAMA/LIBRA and they cannot contribute to the observed modulation amplitude.

+ In no case neutrons (of whatever origin) can mimic the DM annual modulation signature since some of the peculiar requirements of the signature would fail, such as the neutrons would induce e.g. variations in all the energy spectrum, variation in the multiple hit events,... which were not observed.
Summary of the results obtained in the additional investigations of possible systematics or side reactions – **DAMA/LIBRA**

<table>
<thead>
<tr>
<th>Source</th>
<th>Main comment</th>
<th><strong>Cautious upper limit (90%C.L.)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>RADON</td>
<td>Sealed Cu box in HP Nitrogen atmosphere, 3-level of sealing, etc.</td>
<td>$&lt;2.5 \times 10^{-6}$ cpd/kg/keV</td>
</tr>
<tr>
<td>TEMPERATURE</td>
<td>Installation is air conditioned+ detectors in Cu housings directly in contact with multi-ton shield $\rightarrow$ huge heat capacity $+$ T continuously recorded</td>
<td>$&lt;10^{-4}$ cpd/kg/keV</td>
</tr>
<tr>
<td>NOISE</td>
<td>Effective full noise rejection near threshold</td>
<td>$&lt;10^{-4}$ cpd/kg/keV</td>
</tr>
<tr>
<td>ENERGY SCALE</td>
<td>Routine $+$ intrinsic calibrations</td>
<td>$&lt;1-2 \times 10^{-4}$ cpd/kg/keV</td>
</tr>
<tr>
<td>EFFICIENCIES</td>
<td>Regularly measured by dedicated calibrations</td>
<td>$&lt;10^{-4}$ cpd/kg/keV</td>
</tr>
<tr>
<td>BACKGROUND</td>
<td>No modulation above 6 keV; no modulation in the (2-6) keV multiple-hits events; this limit includes all possible sources of background</td>
<td>$&lt;10^{-4}$ cpd/kg/keV</td>
</tr>
<tr>
<td>SIDE REACTIONS</td>
<td>Muon flux variation measured at LNGS</td>
<td>$&lt;3 \times 10^{-5}$ cpd/kg/keV</td>
</tr>
</tbody>
</table>

+ they cannot satisfy all the requirements of annual modulation signature

Thus, they cannot mimic the observed annual modulation effect.
Model-independent evidence by DAMA/Nal and DAMA/LIBRA-ph1, -ph2

well compatible with several candidates in many astrophysical, nuclear and particle physics scenarios

Just few examples of interpretation of the annual modulation in terms of candidate particles in some scenarios

- **50 GeV**
  - Evans' logarithmic

- **65 GeV**
  - Evans' logarithmic

- **15 GeV**
  - Isothermal sphere (channeling)

- **20 GeV**
  - Evans' power law (channeling)

- **LDM with coherent scattering on nuclei**

- **LDM with \( m_L = 0 \) GeV**
  - \( \delta = m_H \)
Is it an “universal” and “correct” way to approach the problem of DM and comparisons?

No, it isn’t. This is just a largely arbitrary/partial/incorrect exercise
...and experimental aspects...

- Exposures
- Energy threshold
- Detector response (phe/keV)
- Energy scale and energy resolution
- Calibrations
- Stability of all the operating conditions.
- Selections of detectors and of data.
- Subtraction/rejection procedures and stability in time of all the selected windows and related quantities
- Efficiencies
- Definition of fiducial volume and non-uniformity
- Quenching factors, channeling, ...
- ...

Uncertainty in experimental parameters, as well as necessary assumptions on various related astrophysical, nuclear and particle-physics aspects, affect all the results at various extent, both in terms of exclusion plots and in terms of allowed regions/volumes. Thus comparisons with a fixed set of assumptions and parameters’ values are intrinsically strongly uncertain.

No experiment can be directly compared in model independent way with DAMA
example...

case of DM particles inducing elastic scatterings on target-nuclei, SI case

Regions in the nucleon cross section vs DM particle mass plane

- Some velocity distributions and uncertainties considered.
- The DAMA regions represent the domain where the likelihood-function values differ more than 7.5σ from the null hypothesis (absence of modulation).
- For CoGeNT a fixed value for the Ge quenching factor and a Helm form factor with fixed parameters are assumed.
- The CoGeNT region includes configurations whose likelihood-function values differ more than 1.64σ from the null hypothesis (absence of modulation). This corresponds roughly to 90% C.L. far from zero signal.

DAMA allowed regions for a particular set of astrophysical, nuclear and particle Physics assumptions without (green), with (blue) channeling, with energy-dependent Quenching Factors (red);

7.5 σ C.L.

CoGeNT; qf at fixed assumed value

1.64 σ C.L.

Including the Migdal effect → Towards lower mass/higher σ

Co-rotating halo, Non thermalized component → Enlarge allowed region towards larger mass

Combining channeling and energy dependence of q.f. (AstrPhys33 (2010) 40) → Towards lower σ
Running phase2 and towards future DAMA/LIBRA–phase3 with software energy threshold below 1 keV

Enhancing sensitivities for DM corollary aspects, other DM features, second order effects and other rare processes:

- The light collection of the detectors can further be improved
- Light yields and the energy thresholds will improve accordingly
- The electronics can be improved too

R&D towards possible DAMA/LIBRA-phase3 continuing:

1. new development of high Q.E. PMTs with increased radio-purity to directly couple them to the crystals.
2. new protocols for possible modifications of the detectors;
3. alternative strategies under investigation.
4. Other possible option: new ULB crystal scintillators (e.g. ZnWO₄) placed in between the DAMA/LIBRA detectors to add also a high sensitivity directionality measurement.

The presently-reached metallic PMTs features:

- Q.E. around 35-40% @ 420 nm (NaI(Tl) light)
- Radio-purity at level of 5 mBq/PMT (⁴₀K), 3-4 mBq/PMT (²³²Th), 3-4 mBq/PMT (²³⁸U), 1 mBq/PMT (²²⁶Ra), 2 mBq/PMT (⁶⁰Co).
Conclusions

- Model-independent positive evidence for the presence of DM particles in the galactic halo at 12.9σ C.L. (20 independent annual cycles with 3 different set-ups: 2.46 ton × yr)
- Modulation parameters determined with increasing precision
- New investigations on different peculiarities of the DM signal exploited in progress
- Full sensitivity to many kinds of DM candidates and interactions types (both inducing recoils and/or e.m. radiation), full sensitivity to low and high mass candidates

- DAMA/LIBRA–phase2 continuing data taking
- DAMA/LIBRA–phase3 R&D in progress
- R&D for a possible DAMA/1ton - full sensitive mass - set-up, proposed to INFN by DAMA since 1996, continuing at some extent as well as some other R&Ds
- New corollary analyses in progress
- Continuing investigations of rare processes other than DM