

**exp()** — Exponentiation and logarithms
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## Description

`exp(Z)` returns the elementwise exponentiation of  $Z$ . `exp()` returns real if  $Z$  is real and complex if  $Z$  is complex.

`ln(Z)` and `log(Z)` return the elementwise natural logarithm of  $Z$ . The functions are synonyms. `ln()` and `log()` return real if  $Z$  is real and complex if  $Z$  is complex.

`ln(x)`,  $x$  real, returns the natural logarithm of  $x$  or returns missing (`.`) if  $x \leq 0$ .

`ln(z)`,  $z$  complex, returns the complex natural logarithm of  $z$ . `Im(ln())` is chosen to be in the interval  $(-pi, pi]$ .

`log10(Z)` returns the elementwise log base 10 of  $Z$ . `log10()` returns real if  $Z$  is real and complex if  $Z$  is complex. `log10(Z)` is defined mathematically and operationally as `ln(Z)/ln(10)`.

`expm1(Z)` returns `exp(z) - 1` for every element  $z$  of real matrix  $Z$ . `expm1(z)` is more accurate than `exp(z) - 1` for small values of  $|z|$ .

`ln1p(Z)` and `log1p(Z)` return `log(1 + z)` for every element  $z$  of real matrix  $Z$ . The functions are synonyms. `ln1p(z)` is more accurate than `ln(1 + z)` for small values of  $|z|$ .

`ln1m(Z)` and `log1m(Z)` return `log(1 - z)` for every element  $z$  of real matrix  $Z$ . The functions are synonyms. `ln1m(z)` is more accurate than `ln(1 - z)` for small values of  $|z|$ .

## Syntax

*numeric matrix* `exp(numeric matrix Z)`

*numeric matrix* `ln(numeric matrix Z)`

*numeric matrix* `log(numeric matrix Z)`

*numeric matrix* `log10(numeric matrix Z)`

*numeric matrix* `expm1(numeric matrix Z)`

*numeric matrix* `ln1p(numeric matrix Z)`

*numeric matrix* `log1p(numeric matrix Z)`

*numeric matrix* `ln1m(numeric matrix Z)`

*numeric matrix* `log1m(numeric matrix Z)`

## Conformability

`exp(Z)`, `ln(Z)`, `log(Z)`, `log10(Z)`, `expm1(Z)`, `ln1p(Z)`, `log1p(Z)`, `ln1m(Z)`, `log1m(Z)`:

*Z*:  $r \times c$   
*result*:  $r \times c$

## Diagnostics

`exp(Z)` returns missing when  $\text{Re}(Z) > 709$ .

`ln(Z)`, `log(Z)`, and `log10(Z)` return missing when  $Z$  is real and  $Z \leq 0$ . In addition, the functions return missing (.) for real arguments when the result would be complex. For instance, `ln(-1) = .`, whereas `ln(-1+0i) = 3.14159265i`.

`expm1(Z)` returns missing when  $Z > 709$ .

`ln1p(z)` and `log1p(z)` return missing when  $1 + z \leq 0$ .

`ln1m(z)` and `log1m(z)` return missing when  $1 - z \leq 0$ .

## Also see

[\[M-4\] Scalar](#) — Scalar mathematical functions

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