

Citing Macaulay2 Packages

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The `PackageCitations` [33] package for `Macaulay2` [70] gives the user a quick method for producing a `bibtex` entry of any `Macaulay2` package for inclusion in the bibliography of a \LaTeX document. The `cite` method works “out of the box” on all packages with the following caveats and exceptions.

1. **No Authors:** The packages `Style` [1] and `Text` [2] have no credited authors and so, in turn, neither do their references. Applying `cite` to either of these packages yields a citation with an empty `author` tag and a printed warning similar to

Warning: The "Text" package provides insufficient citation data: author.

Package writers are encouraged to give data for at least one author of the package.

2. **Authors and Contributors:** There are a number of packages that slightly abuse the `Authors` key in their option table by listing certain people as “contributors”. The `cite` method ignores contributing authors for the time being. See, e.g., [7, 22, 24, 73]. It might be a good idea to encourage package writers to only list authors that should appear on the citation in the option table and to credit contributors in the documentation of the package.
3. **Titles for source code:** For a package `Foo`, the `cite` method attempts to make a reasonable title from the package name and headline. We call the headline `H` of `Foo` *good* if it satisfies each of the following properties:
 - `H` consists of at least one word and at most ten words;
 - `H` does not contain a colon;

- H is not Foo nor some slight variation of it.

If H satisfies these properties then the title given in the citation will be `Foo: H`. See, e.g., [33]. Otherwise the title will be the more generic `Foo: A Macaulay2 package`. See, e.g., [120]. The `cite` method can handle quotes (see, e.g., [39]) and will transform any occurrence of the string “Macaulay2” into *Macaulay2*. Moreover, the tex string in [159] is handled properly. However, package writers might be encouraged to avoid using quotes and tex strings in their package headlines as a general rule.

4. **No link to source:** It is possible that, by oversight or policy, an external *Macaulay2* package `Foo` can provide no link to its source code. See, e.g., [27]. In this case `cite` returns a partial citation and issues the warning:

Warning: The "Foo" package provides insufficient citation data: howpublished.

5. **Certified Packages:** For *certified* *Macaulay2* packages, the method `cite` gives two citations: one for the version of the source code being used, and one for the journal article certifying the package. See, for example, [8, 9] or [10, 11].
6. **Diacritics:** The following collection of diacritics are handled properly by the method `cite`: á, â, æ, è, é, ò, ø. See, e.g., [10, 108, 72]. These are all that are needed for `cite` to work with the *Macaulay2* packages presently available but may need to be extended in the future.
7. **Suspected Typos:** The `cite` method makes no attempts to rectify typographical errors in the data provided by the source code. The user has been warned. For possible typos in titles see, e.g., [39, 41, 58]. For possible typos in version numbers see [126].
8. **Miscellaneous Bugs:** The string “Macaulay 2” in the citation of the `LexIdeals` package [53] should be *Macaulay2*.

References

- [1] Style: style sheets and images for the documentation. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [2] Text: documentation and hypertext. Version 0.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [3] Hirotachi Abo, Wolfram Decker, David Eisenbud, Frank Schreyer, Gregory G. Smith, and Mike Stillman. BGG: Bernstein-Gelfand-Gelfand correspondence. Version 1.4.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [4] Tair Akhmejanov. Permanents: Compute the permanents of a matrix. Version 0.9. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [5] Katie Ansal di, David Eisenbud, Robert Krone, and Jay Yang. RandomIdeals: a package for creating random ideals of various sorts. Version 2.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [6] Katie Ansal di, David Eisenbud, Robert Krone, and Jay Yang. ResidualIntersections: Package for studying conditions associated to Residual Intersection theory. Version 1.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [7] Brett Barwick, Thomas Enkosky, Branden Stone, and Jim Vallingdham. Visualize: A *Macaulay2* package. Version 0.8. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [8] Brett Barwick and Branden Stone. QuillenSuslin: A *Macaulay2* package. Version 1.7. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [9] Brett Barwick and Branden Stone. Computing free bases for projective modules. *The Journal of Software for Algebra and Geometry*, 5, 2013.
- [10] René Birkner. Polyhedra: A package for computations with convex polyhedra. Version 1.3. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [11] René Birkner. Polyhedra: a package for computations with convex polyhedral objects. *The Journal of Software for Algebra and Geometry: Macaulay2*, 1, 2009.

- [12] René Birkner, Nathan Owen Ilten, and Lars Petersen. ToricVectorBundles: A package for computations with vector bundles on toric varieties. Version 1.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [13] René Birkner, Nathan Owen Ilten, and Lars Petersen. Computations with equivariant toric vector bundles. *The Journal of Software for Algebra and Geometry: Macaulay2*, 2, 2010.
- [14] Janko Boehm. AdjointIdeal: Adjoint ideals of plane curves and related computations. Version 0.6. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [15] Janko Boehm. ConvexInterface: Interface to Convex. Version 0.33. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [16] Janko Boehm. MapleInterface: Interface to Maple. Version 0.3. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [17] Janko Boehm. Parametrization: Rational parametrization of rational plane curves and related computations. Version 0.6. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [18] Janko Boehm. SRdeformations: Deformations of Stanley-Reisner rings and related computations. Version 0.51. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [19] Janko Boehm and Stavros Papadakis. KustinMiller: Unprojection and the Kustin-Miller complex construction. Version 1.4. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [20] Janko Boehm and Stavros Papadakis. Implementing the Kustin-Miller complex construction. *The Journal of Software for Algebra and Geometry: Macaulay2*, 4, 2012.
- [21] Nicolás Botbol, Laurent Busé, and Manuel Dubinsky. EliminationMatrices: Package for computing resultants. Version 1.4. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [22] Jack Burkart, David Cook II, Caroline Jansen, Amelia Taylor, and Augustine O’Keefe. Graphs: Package for processing graphs and directed graphs (digraphs). Version 0.3.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [23] Baptiste Calmès and Viktor Petrov. FormalGroupLaws: Package to deal with commutative formal group laws. Version 0.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [24] Baptiste Calmès and Viktor Petrov. Graphics: Create graphics. Version 0.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [25] Baptiste Calmès and Viktor Petrov. WeylGroups: Root systems and Weyl groups. Version 0.5.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [26] Edward Carter. Kronecker: Kronecker and rational normal forms. Version 0.3.3. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [27] Justin Chen. Matroids: A *Macaulay2* package. Version 0.2. Available at.
- [28] Lars Winther Christensen and Oana Veliche. CodepthThree: A *Macaulay2* package. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [29] Lars Winther Christensen and Oana Veliche. Local rings of embedding codepth 3: A classification algorithm. *The Journal of Software for Algebra and Geometry*, 6, 2014.
- [30] Charley Crissman. Book3264Examples: Examples to accompany the eponymous book by Eisenbud and Harris. Version 0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [31] Ferran Dachs-Cadefau. MultiplierIdealsDim2: Package for computing MI in 2-dimensional rings. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [32] Aaron Dall. MatroidActivities: A *Macaulay2* software package for computing with ordered matroids. Version 0.2. Available at <https://github.com/aarondall/MatroidActivities-M2>.
- [33] Aaron Dall. PackageCitations: A *Macaulay2* software package facilitating citation of *Macaulay2* packages. Version 0.1. Available at <https://github.com/aarondall/PackageCitations-M2>.
- [34] Hiep Dang. EnumerationCurves: Enumeration of rational curves via torus actions. Version 0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [35] Graham Denham and Gregory G. Smith. HyperplaneArrangements: A *Macaulay2* package. Version 0.9. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [36] Jane Doe. FirstPackage: an example *Macaulay2* package. Version 1.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [37] Jane Doe. PackageTemplate: an example *Macaulay2* package. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [38] David Eisenbud. AnalyzeSheafOnP1: Decompose a Sheaf on P^1 . Version 0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [39] David Eisenbud. Bruns: make a 3-generator ideal with an “any” resolution. Version 2.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [40] David Eisenbud. CompleteIntersectionResolutions: Analyzing Resolutions over a Complete Intersection. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [41] David Eisenbud. HigherCIOperators: Higer CI operators. Version 0.5. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [42] David Eisenbud. MCMApproximations: MCM Approximations and Complete Intersections. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [43] David Eisenbud, Janko Boehm, and Max Nitsche. MonomialAlgebras: A *Macaulay2* package. Version 2.3. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [44] David Eisenbud, Janko Boehm, and Max Nitsche. Decomposition of Monomial Algebras: Applications and Algorithms. *The Journal of Software for Algebra and Geometry*, 5, 2013.
- [45] David Eisenbud, Daniel Erman, Gregory G. Smith, and Dumitru Stamate. TensorComplexes: multilinear algebra with labeled bases. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [46] David Eisenbud, Frank Moore, Frank-Olaf Schreyer, and Greg Smith. ChainComplexExtras: Some additional ChainComplex Functions. Version 1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [47] David Eisenbud, Frank Schreyer, Mike Stillman, Courtney Gibbons, and Branden Stone. BoijSoederberg: betti diagram operations useful for investigating the Boij-Soederberg conjectures. Version 1.5. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [48] David Eisenbud and Mike Stillman. BeginningMacaulay2: Mathematicians' Introduction to *Macaulay2*. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [49] David Eisenbud and Mike Stillman. LocalRings: Local rings at the origin. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [50] David Eisenbud, Amelia Taylor, Sorin Popescu, and Michael E. Stillman. ReesAlgebra: A *Macaulay2* package. Version 1.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [51] Daniel Erman, David Eisenbud, and Frank-Olaf Schreyer. TateOnProducts: Tate resolutions on products of projective spaces. Version 0.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [52] Gunnar Floystad. Triplets: Triplets of degree sequences, and associated Betti diagrams and cohomology tables. Version 0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [53] Chris Francisco. LexIdeals: A Macaulay 2 package for manipulating lexicographic-type monomial ideals. Version 1.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [54] Chris Francisco, Andrew Hoefel, and Adam Van Tuyl. EdgeIdeals: a package for edge ideals. Version 1.0.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [55] Chris Francisco, Andrew Hoefel, and Adam Van Tuyl. EdgeIdeals: a package for (hyper)graphs. *The Journal of Software for Algebra and Geometry: Macaulay2*, 1, 2009.
- [56] Federico Galetto. HighestWeights: A *Macaulay2* package. Version 0.6.5. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [57] Federico Galetto. Free resolutions and modules with a semisimple Lie group action. *The Journal of Software for Algebra and Geometry*, 7, 2015.
- [58] Luis Garcia and Mike Stillman. Markov: Markov ideals, arising from Bayesian networks in statistics. Version 1.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [59] Luis Garcia-Puente, Sonja Petrovic, Mike Stillman, and Seth Sullivant. GraphicalModels: A package for discrete and Gaussian graphical models. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [60] Luis Garcia-Puente, Sonja Petrovic, Mike Stillman, and Seth Sullivant. Graphical Models. *The Journal of Software for Algebra and Geometry*, 5, 2013.
- [61] Dan Grayson. Units: units conversion and physical constants. Version 0.9. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [62] Dan Grayson. XML: an XML parser. Version 1.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [63] Dan Grayson and Mike Stillman. SimpleDoc: a simple documentation function. Version 1.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [64] Daniel R. Grayson. Browse: a method for browsing and examining *Macaulay2* data structures. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [65] Daniel R. Grayson. Classic: a classic Macaulay parser. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [66] Daniel R. Grayson. ConwayPolynomials: a database of Conway polynomials. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [67] Daniel R. Grayson. EllipticIntegrals: uniformization of elliptic curves. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [68] Daniel R. Grayson. Serialization: reversible conversion of all *Macaulay2* objects to strings. Version 0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [69] Daniel R. Grayson and Michael E. Stillman. Benchmark: standard *Macaulay2* benchmarks. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [70] Daniel R. Grayson and Michael E. Stillman. Macaulay2, a software system for research in algebraic geometry. Available at <http://www.math.uiuc.edu/Macaulay2/>.
- [71] Daniel R. Grayson and Michael E. Stillman. Macaulay2Doc: A *Macaulay2* package. Version 1.9.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [72] Daniel R. Grayson, Michael E. Stillman, Stein A. Strømme, David Eisenbud, and Charley Crissman. Schubert2: computations of characteristic classes for varieties without equations. Version 0.7.

Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [73] Elizabeth Gross, Sonja Petrovic, and Jan Verschelde. PHCpack: Interface to PHCpack. Version 1.6.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [74] Elizabeth Gross, Sonja Petrovic, and Jan Verschelde. Interfacing with PHCpack. *The Journal of Software for Algebra and Geometry*, 5, 2013.
- [75] Elizabeth Gross, Jose Israel Rodriguez, Dan Bates, and Anton Leykin. Bertini: Interface to Bertini. Version 2.1.2.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [76] Thomas Hawes. InvariantRing: A *Macaulay2* package. Version 1.1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [77] Thomas Hawes. Computing the invariant ring of a finite group. *The Journal of Software for Algebra and Geometry*, 5, 2013.
- [78] Martin Helmer and Christine Jost. CharacteristicClasses: A *Macaulay2* package. Version 2.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [79] Martin Helmer and Christine Jost. Computing characteristic classes and the topological Euler characteristic of complex projective schemes. *The Journal of Software for Algebra and Geometry*, 7, 2015.
- [80] Chris Hillar, Robert Krone, and Anton Leykin. EquivariantGB: Equivariant Groebner bases and related algorithms. Version 0.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [81] Franziska Hinkelmann, Mike Stillman, and Elizabeth Arnold. BooleanGB: Groebner Bases for Ideals in Boolean Polynomial Quotient Ring. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [82] Bradford Hovinen. ModuleDeformations: Computing versal deformations of maximal Cohen-Macaulay modules. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [83] Bradford Hovinen. Deformations of Matrix Factorisations with *Macaulay2*. *The Journal of Software for Algebra and Geometry: Macaulay2*, 2, 2010.
- [84] Craig Huneke and David Eisenbud. TangentCone: A *Macaulay2* package. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [85] David Cook II. Nauty: Interface to nauty. Version 1.4.3.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [86] David Cook II. NautyGraphs: Interface to nauty (Graphs fork). Version 1.4.3.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [87] David Cook II. SimplicialDecomposability: various decomposability routines for simplicial complexes. Version 1.0.6. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [88] David Cook II. Simplicial Decomposability. *The Journal of Software for Algebra and Geometry: Macaulay2*, 2, 2010.
- [89] David Cook II. Nauty in *Macaulay2*. *The Journal of Software for Algebra and Geometry: Macaulay2*, 3, 2011.
- [90] David Cook II, Sonja Mapes, and Gwyn Whieldon. Posets: Package for processing partially ordered sets (posets). Version 1.1.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [91] David Cook II, Sonja Mapes, and Gwyn Whieldon. Partially ordered sets in *Macaulay2*. *The Journal of Software for Algebra and Geometry*, 7, 2015.
- [92] Nathan Owen Ilten. VersalDeformations: A package for calculating versal deformations and local Hilbert schemes. Version 1.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [93] Nathan Owen Ilten. Versal deformations and local Hilbert schemes. *The Journal of Software for Algebra and Geometry: Macaulay2*, 4, 2012.

- [94] Gesa Kaempf and Christof Soeger. Normaliz: a package to use Normaliz in Macaulay 2. Version 2.6. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [95] Gesa Kaempf and Christof Soeger. A *Macaulay2* interface for Normaliz. *The Journal of Software for Algebra and Geometry: Macaulay2*, 2, 2010.
- [96] Thomas Kahle. Binomials: Specialized routines for binomial ideals. Version 1.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [97] Thomas Kahle. Cyclotomic: Routines for cyclotomic fields. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [98] Thomas Kahle. Decompositions of binomial ideals. *The Journal of Software for Algebra and Geometry: Macaulay2*, 4, 2012.
- [99] Robert Krone. NumericalHilbert: numerically compute local dual space and Hilbert functions. Version 0.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [100] Douglas A. Leonard. QthPower: An implementation of the Qth-Power algorithm for computing integral closures. Version 1.02. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [101] Anton Leykin. ExampleSystems: examples of polynomial systems. Version 0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [102] Anton Leykin. NAGtypes: Common types used in Numerical Algebraic Geometry. Version 1.9. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [103] Anton Leykin. SLPexpressions: Straight Line Programs and Algebraic Circuits. Version 1.9. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [104] Anton Leykin, Abraham Martin del Campo, and Jan Verschelde. NumericalSchubertCalculus: a *Macaulay2* package for using numerical methods in Schubert Calculus. Version 0.4. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [105] Anton Leykin and Robert Krone. NumericalAlgebraicGeometry: A *Macaulay2* package. Version 1.9. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [106] Anton Leykin and Robert Krone. Numerical Algebraic Geometry. *The Journal of Software for Algebra and Geometry: Macaulay2*, 3, 2011.
- [107] Anton Leykin and Harrison Tsai. Dmodules: functions for computations with D-modules. Version 1.4.0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [108] Anders Lundman and Gustav Sædén Ståhl. LatticePolytopes: A package for computations with lattice polytopes. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [109] Han-Bom Moon and David Swinarski. M0nbar: A *Macaulay2* package. Version 0.3. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [110] Frank Moore. DGAlgebras: Data type for DG algebras. Version 0.8. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [111] Frank Moore, Mike Stillman, and Franziska Hinkelmann. Minimal-Primes: minimal primes of an ideal. Version 0.9. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [112] Alessandro Oneto and Stefano Marseglia. EllipticCurves: A *Macaulay2* package. Version 0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [113] Brian Pike. RunExternalM2: run *Macaulay2* functions outside the current *Macaulay2* process. Version 0.83. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [114] Brian Pike. VectorFields: a package for computations with vector fields. Version 1.80. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [115] Sorin Popescu, Gregory G. Smith, and Mike Stillman. SimplicialComplexes: A *Macaulay2* package. Version 1.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [116] Claudiu Raicu. PushForward: push forwards of finite ring maps. Version 0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [117] Daniel Robertz. InvolutiveBases: Methods for Janet bases and Pom-maret bases in Macaulay 2. Version 1.10. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [118] Dan Roozemon. OpenMath: OpenMath for *Macaulay2*. Version 0.2.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [119] Dan Roozemon. SCSCP: SCSCP for *Macaulay2*. Version 0.2.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [120] Steven V Sam. PieriMaps: A *Macaulay2* package. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [121] Steven V Sam. Computing inclusions of Schur modules. *The Journal of Software for Algebra and Geometry: Macaulay2*, 1, 2009.
- [122] Frank-Olaf Schreyer and Hans-Christian Graf v. Bothmer. Random-CanonicalCurves: Construction of random smooth canonical curves up to genus 14. Version 0.6. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [123] Frank-Olaf Schreyer and Hans-Christian Graf v. Bothmer. Random-Genus14Curves: Construction of random smooth curves of genus 14. Version 0.6. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [124] Frank-Olaf Schreyer, Hans-Christian Graf v. Bothmer, and Florian Geiss. RandomCurves: Construction of random curves. Version 0.6. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [125] Karl Schwede, Daniel Smolkin, S. Hamid Hassanzadeh, and C.J. Bott. RationalMaps: A package for working with rational maps. Version 0.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [126] Karl Schwede and Zhaoning Yang. Divisor: A package for working with Weil divisors. Version 0.1p. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [127] Alexandra Seceleanu. SymmetricPolynomials: A *Macaulay2* package. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [128] Alexandra Seceleanu and Nathaniel Stapleton. GenericInitialIdeal: find the generic initial ideal of a given ideal. Version 0.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [129] Alexandra Seceleanu and Nathaniel Stapleton. Regularity: computes the Castelnuovo-Mumford regularity of a given homogeneous ideal. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [130] Gregory G. Smith. FourierMotzkin: convex hulls and polar cones. Version 1.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [131] Gregory G. Smith. NormalToricVarieties: A *Macaulay2* package. Version 1.3. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [132] Bart Snapp, David Eisenbud, and Branden Stone. Depth: aids in computations related to depth. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [133] Bart Snapp and Nathaniel Stapleton. NoetherNormalization: place an ideal in Noether normal position. Version 0.9.3. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [134] Giovanni Staglianò. Cremona: Some computations for rational maps between projective varieties. Version 2.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [135] Giovanni Staglianò. MultipolynomialResultants: Resultants and discriminants for multivariate polynomials. Version 1.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [136] Gustav Sædén Ståhl. FiniteFittingIdeals: A package for computing Fitting ideals of finite modules. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [137] Nathaniel Stapleton. RationalPoints: A *Macaulay2* package. Version 0.95. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [138] Michael Stillman, Hal Schenck, and Claudiu Raicu. SchurRings: representation rings of general linear groups and of symmetric groups. Version 1.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [139] Michael E. Stillman. Elimination: a package for elimination of variables. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [140] Michael E. Stillman. LLLBases: a package for computing Lenstra-Lenstra-Lovasz bases. Version 1.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [141] Michael E. Stillman. PrimaryDecomposition: functions for primary decomposition. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [142] Michael E. Stillman, Anton Leykin, and Mauricio Velasco. Schur-Functors: computations of Schur modules and maps between them. Version 0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [143] Mike Stillman and Andrew Hoefel. gfanInterface: Interface to A. Jensen's gfan package. Version 0.2.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [144] Mike Stillman, Gregory G. Smith, Stein A. Strømme, and David Eisenbud. Points: computing with sets of points. Version 2.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [145] Mike Stillman, Josephine Yu, and Sonja Petrovic. FourTiTwo: Interface to 4ti2. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [146] Joe Suzuki. Miura: A *Macaulay2* package. Version 0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [147] Dave Swinarski. ConformalBlocks: for conformal block divisors. Version 2.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [148] Dave Swinarski. LieTypes: Common types for Lie groups and Lie algebras. Version 0.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [149] Dave Swinarski. StatePolytope: for computing the state polytope of an ideal. Version 1.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [150] Amelia Taylor, David Eisenbud, and Mike Stillman. IntegralClosure: A *Macaulay2* package. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [151] Zach Teitler, Bart Snapp, and Claudiu Raicu. MultiplierIdeals: A *Macaulay2* package. Version 1.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [152] Zach Teitler, Bart Snapp, and Claudiu Raicu. Software for multiplier ideals. *The Journal of Software for Algebra and Geometry*, 7, 2015.
- [153] Alvis Trevisan and Alexander I. Suci. ToricTopology: A *Macaulay2* package. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [154] Hans-Christian Graf v. Bothmer, Florian Geiss, Daniel R. Grayson, and Frank-Olaf Schreyer. RandomObjects: a framework for making random objects in algebraic geometry. Version 0.2. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [155] Hans-Christian Graf v. Bothmer, Florian Geiss, and Frank-Olaf Schreyer. RandomPlaneCurves: Construction of random plane curves. Version 0.6. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.

- [156] Hans-Christian Graf v. Bothmer, Florian Geiss, and Frank-Olaf Schreyer. RandomSpaceCurves: Construction of random smooth space curves. Version 0.5. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [157] Tobias Windisch. BinomialEdgeIdeals: Package for computations with binomial edge ideals. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [158] Stephanie Yang. HodgeIntegrals: Hodge integrals on the moduli space of curves. Version 1.2.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [159] Stephanie Yang. Intersection numbers on $Mbar_{g,n}$. *The Journal of Software for Algebra and Geometry: Macaulay2*, 2, 2010.
- [160] Josephine Yu. Polymake: a package for interfacing with polymake. Version 0.1. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [161] Mikhail Zinin. BIBasis: Involution Pommaret basis in a Boolean ring. Version 0.6.3. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.
- [162] Daniel R. Grayson (). Parsing: a framework for creating recursive descent parsers. Version 1.0. Available at <https://github.com/Macaulay2/M2/tree/master/M2/Macaulay2/packages>.