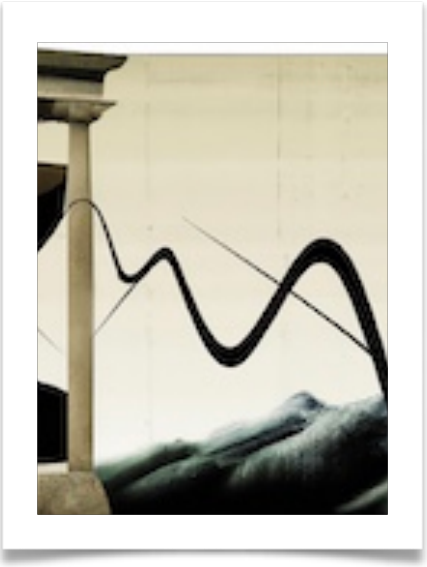

Non-stationarity, cyclostationarity and applications

June 5th 2023 - June 7th 2023

Université Paris Nanterre

Labex MME-DII
Modèles Mathématiques et Économiques de la Dynamique, de l'Incertitude et des Interactions

Invited speakers

Radoslaw Adamczak	University of Warsaw, Poland
Jean-Marc Bardet	Université Paris 1 Panthéon-Sorbonne
Frédérique Bec	Université de Cergy, France
Alexander Braumann	Technische Universität Braunschweig, Germany
Gilles de Truchis	Université d'Orléans, France
Paul Doukhan	Université de Cergy, France
Thierry Dumont	Université Paris Nanterre
Carlos Fernandez	University Paris Nanterre
Valérie Girardin	Université de Caen, France
Karin Heidlmayr	Université Paris Nanterre
Jens-Peter Kreiss	Technische Universität Braunschweig, Germany
Soumendra Lahiri	Washington University in Saint Louis, USA
Emilie Lebarbier	Université Paris Nanterre
Lukasz Lenart	Krakow University of Economics, Poland
Aldo Medina Garay	Federal University of Pernambuco, Brazil
Bartosz Majewski	AGH university, Krakow, Poland
Nicolas Marie	Université Paris Nanterre
Antonio Napolitano	Pathenope University, Napoli, Italy
Michael Neumann	Friedrich-Schiller-Universität Jena, Germany
Hernando Ombao	KAUST, Saudi Arabia
Stathis Paparoditis	University of Cyprus, Cyprus
François Roueff	Telecom Paris
Jamel Saadaoui	Université de Strasbourg, France
Suhasini Subba Rao	Texas A&M, USA
Rainer von Sachs	Université Catholique de Louvain, Belgique
Jean-Michel Zakoian	ENSAE Paris

Planning

	Lundi	Mardi	Mercredi
8h45	Accueil		
9h	Doukhan	Lahiri	Lenart
9h40	Lebarbier	Kreiss	Napolitano
10h20	Pause café	Pause café	Pause café
10h40	Marie	Braumann	Dumont
11h20	Adamczak	Paparoditis	Fernandez
12h	Déjeuner	Déjeuner	Déjeuner
13h50	Saadaoui	Roueff	Majewski
14h30	Bec	Garay	Von Sachs
15h10	de Truchis	Girardin	
15h50	Pause café	Pause café	
16h10	Bardet	Ombao	
16h50	Neumann	Heidlmayr	
17h30	Zakoian	Rao	

Abstracts

Radoslaw Adamczak

Title: *Concentration inequalities under negative dependence*.

Abstract. I will describe concentration inequalities for certain negatively dependent binary random variables. I will focus on the class of SCP measures introduced by Pemantle and Peres and then specialize to independent Bernoulli variables conditioned on their sum (generalizing uniform measures on sections of the discrete cube studied previously by Gao-Quastel and Bobkov-Tetali). The methods are based on martingale and functional inequalities.

Jean-Marc Bardet

Title: *Contrast estimation of time-varying infinite memory processes*.

Abstract. This talk is dedicated to the extension of a study of kernel-based estimation for locally stationary processes proposed in Dahlhaus et al. (2018) to infinite-memory processes models such as locally stationary AR(∞), GARCH(p, q), ARCH(∞) or LARCH(∞) processes. The estimators are computed as localized M-estimators for every contrast satisfying appropriate regularity conditions. We prove the uniform consistency and pointwise asymptotic normality of such kernel-based estimators. We apply our results to common contrasts such as least-square, least-absolute-value, or quasi-maximum likelihood contrast. Numerical experiments demonstrate the efficiency of the estimators on both simulated and real data sets.

Frédérique Bec

Title: *Power of unit root tests against nonlinear and noncausal alternatives, with an application to the Brent crude oil price*.

Abstract. The increasing sophistication of economic and financial time series modeling creates a need for a test of the time dependence structure of the series which does not require a proper specification of the alternative. Indeed, the latter is unknown beforehand. Yet, the stationarity has to be established before proceeding to the estimation and testing of causal/noncausal or linear/nonlinear models as their econometric theory has been developed under the maintained assumption of stationarity. In this talk, we propose a new unit root test statistics which is both asymptotically consistent against all stationary alternatives and still keeps good power properties in finite sample. A large simulation study is performed to assess the power of our test compared to existing unit root tests built specifically for various kinds of stationary alternatives, when the true DGP is either causal or noncausal, linear or nonlinear stationary. Based on various sample sizes and degrees of persistence, it turns out that our new test performs very well in terms of power in finite sample, no matter the alternative under consideration. The proposed approach is illustrated using recent Brent crude oil price data.

Alexander Braumann

Title: *Bootstrap convergence rates for the maximum of an increasing number of autocovariances and autocorrelations under strict stationarity*.

Abstract. We consider maximum deviations of sample autocovariances and autocorrelations from their theoretical counterparts over an increasing set of lags. The asymptotic distribution of such statistics e.g. for strictly stationary time series is of Gumbel type. However speed of convergence to Gumbel is of logarithmic order. The well-known autoregressive sieve bootstrap is asymptotically valid for the maximum deviations suffering from the same slow convergence rate. However for linear time series the bootstrap speed of convergence is of polynomial order. We investigate whether we can use the idea of Gaussian approximation to show that for the class of strictly stationary processes a hybrid variant of the autoregressive bootstrap is asymptotically valid for our statistic of interest at a polynomial convergence rate.

Gilles de Truchis

Title: *Bet on a bubble asset? An optimal portfolio allocation strategy*.

Abstract. We discuss portfolio allocation when one asset exhibits phases of locally explosive behavior. We model the conditional distribution of such an asset through mixed causal-non-causal models which mimic well the speculative bubble behavior. Relying on a Taylor-series-expansion of a CRRA utility function approach, the optimal portfolio(s) is(are) located on the mean-variance-skewness-kurtosis efficient surface. We analytically derive these four conditional moments and show in a Monte-Carlo simulations exercise that incorporating them into a two-assets portfolio optimization problem leads to substantial improvement in the asset allocation strategy. All performance evaluation metrics support the higher out-of-sample performance of our investment strategies over standard benchmarks such as the mean-variance and equally-weighted portfolio. An empirical illustration using the Brent oil price as the speculative asset confirms these findings.

Paul Doukhan

Title: *A view on some non-stationary models*.

Abstract. Several years ago we tried to promote the idea of non stationarity through a research project in CYU Cergy Paris University 2018.
The ideas developed are enclosed in papers with Jean Marc Bardet and Olivier Wintenberger. We settled more precisely two specific models of interest
- AR(1) with local stationarity and periodic behaviors.
- Infinite memory contractive models with local stationarity.
Moreover a specific non stationary ARMA(1,1) model was also developed to mimic irregularly observed models, with Natalia Bahamonde, Karine Bertin and Jean Marc Bardet for applications to model ray light data in astronomy.

Thierry Dumont

Title: *Capturing oscillations in time series: a semi-parametric HMM approach*.

Abstract. Hidden Markov Models (HMMs) can prove highly valuable in handling nonstationary data. In this presentation, we will introduce a semi-parametric HMM model specifically designed to capture oscillations in quasi-periodic time series, where patterns are modified by alterations in both frequency and amplitude. Our approach utilizes a generalized state space model composed of a hidden phase process governing the frequency and a nonparametric curve characterizing the pattern. We will commence by briefly discussing the identifiability of the model, followed by the introduction of a particle smoother that combines the Kalman smoother with an efficient sequential Monte Carlo smoother. To demonstrate the efficacy of our approach, we will showcase its performance on synthetic data as well as human electrocardiogram recordings.

Carlos Fernandez

Title: *Harris recurrent Markov chains and nonlinear monotone cointegrated models*.

Abstract. In this talk we study a nonlinear cointegration-type model of the form $Z_t = f_0(X_t) + W_t$ where f_0 is a monotone function and (X_t) is a Harris recurrent Markov chain. Using a localization argument, we develop a nonparametric Least Squares Estimator to locally estimate f_0, which, under mild conditions, we show is strongly consistent and we present its rate of convergence.

Valérie Girardin

Title: *Time Changes and Stationarity Issues for Autoregressive Models*.

Abstract. A scalar discrete or continuous time process is reducible to stationarity if its transform by some smooth time change is weakly stationary. Different issues linked to this notion will be here investigated for

autoregressive models. These models are understood in a large sense and may have time-varying coefficients. In the continuous time case, the innovation can be of the semi-martingale type such as compound Poisson noise; in the discrete case, the noise may not be Gaussian.
Necessary and sufficient conditions for scalar models with time varying coefficients to be reducible to stationarity are available, with explicit formulas for the pertinent time changes.
Illustration through simulation includes several classical types of time changes, including the multiplicative stationary autoregressive models.

Karin Heidlmayr

Title: *Neural Oscillatory Mechanisms in Language Processing*.

Abstract. This talk aims at giving a brief overview of the recent developments in the study of neural oscillatory mechanisms in language processing. Two main approaches will be reviewed. Firstly, it will be discussed how spatiotemporal dynamics of neural oscillations can be used as markers of neurocognitive linguistic processes. Secondly, cortical tracking (neural entrainment) of the temporal dynamics of speech will be addressed. Finally, it will briefly be addressed how these approaches have allowed to gain further insight into healthy language processing as well as into alterations in speech and language disorders.

Jens-Peter Kreiss

Title: *Bootstrapping Whittle Estimators*.

Abstract. Fitting parametric models by optimizing frequency domain objective function is an attractive approach to parameter estimation in time series analysis. Whittle estimators are a prominent example in this context. Under weak conditions and the assumption that the true spectral density of the underlying process does not necessarily belong to the parametric class of spectral densities fitted, the distribution of Whittle estimators typically depends on the difficulty in estimating characteristics of the underlying process. This makes the implementation of asymptotic results for the construction of confidence intervals or for assessing the variability of estimators, difficult in practice. A frequency domain bootstrap method is proposed to estimate the distribution of Whittle estimators, which is asymptotically valid under assumptions that not only allow for possible model misspecification but also for weak dependence conditions which are satisfied by a wide range of stationary stochastic processes. Adaptions of the bootstrap procedure developed to incorporate different modifications of Whittle estimators proposed in the literature, like, for instance, tapered, de-biased or boundary-extended Whittle estimators, are also considered. Simulations demonstrate the capabilities of the bootstrap method proposed and its good finite sample performance. A real-life data analysis also is presented.

Soumendra Lahiri

Title: *Bootstrap for a class of non stationary time series*.

Abstract. We consider a regression model where the error variables are generated by a zero-mean process with a nonstationary covariance function. We formulate a version of the Dependent Wild Bootstrap and under some suitable weak dependence condition and some moment conditions, we establish the validity of the proposed resampling scheme for variance estimation and for distributional approximations. The set up is more general than the heteroscedastic case typically considered in the literature.

Emilie Lebarbier

Title: *Multiple change-point detection in a Poisson process*.

Abstract. We consider a Poisson process whose intensity is supposed to be piecewise constant. The objective is to detect the instants of abrupt changes, called change-point, and to determine their number.
The main difficulty concerns the estimation of the change-points. Indeed, the based-likelihood contrast to be optimized for this purpose is not convex and nor even continuous with respect to these parameters. This

problem has been already considered in the literature for the detection of one change-point (see Li (2015) and Yang & Kuo (2001)). Using a concavity argument of the contrast on each time-event intervals, they showed that the optimal change-point is necessarily localized at an event or just before. For the detection of multiple change-points, we use the same idea and show that, for a general class of contrasts satisfying a concavity hypothesis w.r.t the change-points, the optimization problem is thus reduced to a discrete optimization problem which can be solved using a well- efficient algorithm known used in the case of the detection of discrete change-points, the dynamic programming algorithm. The change-points are thus recovered in a exact manner and reasonably fast.
For the choice of the number of change-points, we propose to use a cross-validation method taking advantage of the previous fast algorithm and a specific property of Poisson processes.
Simulation results will be presented as well as an illustration of volcanic eruption data.

Lukasz Lenart

Title: *An exponential smoothing stochastic cycle model with multiple frequencies*.

Abstract. We design a non-linear, multi-frequency stochastic cycle model drawing upon the idea of non-linear innovations state space framework and a direct movement of a sine function with a time-variable amplitude and phase shift driven by autoregression processes. Our specification belongs to the family of exponential smoothing models, and is shown to feature suitable theoretical properties, including stationarity and a pseudo-cyclical autocovariance function, also enabling a direct decomposition of overall cyclic fluctuations into separate cyclic components corresponding to different~frequencies.

Aldo Medina Garay

Title: *Estimation and forecasting of INAR(p) processes with zero-inflated innovations*.

Abstract. In this work, we study a class of p-order non-negative integer-valued autoregressive (INAR(p)) processes, with innovations following zero-inflated (ZI) distributions called ZI-INAR(p) processes. Based on the EM algorithm, we present an estimation procedure of the parameters model.

Bartosz Majewski

Title: *Spectral density estimation for spectrally correlated processes*.

Abstract. We study the estimation problem of the spectral density function for harmonizable nonstationary processes. More precisely, we consider spectrally correlated processes whose spectral measure has the support contained in the union of unknown lines with possibly non-unit slopes. We propose the frequency-smoothed periodogram along the estimated support line as an estimator of the spectral density function. We show the mean-square consistency of the proposed estimator. Additionally, we discuss the estimation of the support line in a specific model with its applications in locating a moving source. Finally, we present simulations confirming the proven results.

Nicolas Marie

Title: *From Nonparametric Regression to Statistical Inference for Non-Ergodic Diffusion Processes*.

Abstract. The purpose of the talk is to present, in general, a recent approach of the estimation in stochastic differential equations based on copies of the solution, and then to present some results on a nonparametric estimator in particular: the projection least squares estimator of the drift function.

Antonio Napolitano

Title: *Oscillatory almost-cyclostationary (OACS) processes are a recently introduced class of signals resulting from the interaction of random phenomena and periodic phenomena with irregular periodicity*.

Abstract. An OACS process admits a Priestley a spectral representation expressed in terms of an oscillatory function and a vector measure of an ACS process. This results in an autocorrelation function which is the superposition of amplitude and angle-modulated sine waves. The ACS processes are obtained as a special case of OACS processes if the oscillatory function is unity. In such a case, the autocorrelation function is the superposition of sine waves with possibly incommensurate frequencies. That is, it is an almost-periodic function of time. The oscillatory processes of Priestley are obtained as a special case of OACS processes if the vector measure has orthogonal increments.
The second-order characterization of OACS processes is presented in both time and frequency domains. The problem of statistical function estimation is addressed. The electrocardiogram signal and the acoustic signal generated by the engine of an aircraft are presented as examples.

Michael Neumann

Title: *Mixing properties of nonlinear Poisson-INGARCH processes*.

Abstract. We derive mixing properties for a broad class of Poisson count time series satisfying a certain contraction condition. Using specific coupling techniques, we prove absolute regularity at a geometric rate not only for stationary Poisson-GARCH processes but also for models with an explosive trend. We provide easily verifiable sufficient conditions for absolute regularity for a variety of models including classical (log-)linear models.

Hernando Ombao

Title: *Spectral Transfer Entropy: A New Causal Inference Approach for Oscillatory Processes*.

Abstract. Brain signals, such as electroencephalograms (EEG), capture neuronal activity on the cortex. During execution of a cognitive function, large amplitude signals are associated to high activity which is an indication of functioning brain regions. The interest now is to infer on the impact of these amplitudes from one brain region to other regions. One approach is to perform causal inference on the oscillatory components of the signals extracted from linear filtering methods by fitting (spectral) vector autoregressive models. However, this problematic because filtering does not always isolate causal relationships into the extracted components. Thus, we develop a new causal measure called spectral transfer entropy (STE) to quantify the amount of information transferred from a brain region's oscillatory signal to an oscillation of another region. Instead of using the actual values from a filtered signal, our STE approach takes advantage of the maximum amplitude of the signals over some overlapping time block scheme. This offers a new paradigm for measuring the causal relationship between high amplitude oscillatory signals that is robust to the issues of linear filtering. To estimate and conduct statistical inferences on STE, we propose an approach that combines vine copulas and extreme value theory. With the vine copula representation, a null copula model, which exhibits zero STE, is defined, making significance testing for STE straightforward through a standard resampling approach. Lastly, we illustrate our proposed measure based on some numerical experiments and provide interesting and novel findings on the analysis of EEG recordings linked to a visual task.

Stathis Paparoditis

Title: *Prediction Bands for Functional Time Series*.

Abstract. A bootstrap procedure for constructing prediction bands for stationary functional time series is proposed. The procedure exploits a general vector autoregressive representation of the time-reversed series of Fourier coefficients appearing in the Karhunen-Loeve representation of the functional process. It generates backward-in-time functional replicates that adequately mimic the dependence structure of the underlying process in a model-free way and have the same conditionally fixed curves at the end of each functional pseudo-time series. The bootstrap prediction error distribution is then calculated as the difference between the model-free bootstrap-generated future functional observations and the functional forecasts obtained from the model used for prediction. This allows the estimated prediction error distribution to account for the innovation and estimation errors associated with prediction and also for the errors due to possible model mis-specification. We establish the asymptotic validity of the bootstrap procedure in estimating the conditional

prediction error distribution of interest, and we also show that the procedure enables the construction of prediction bands that achieve (asymptotically) the desired coverage.

François Roueff

Title: *Fractionally Integrated Autoregressive Moving Average parametric estimation and prediction in a separable Hilbert space*.

Abstract. Long range dependence is sometimes interpreted as a phase transition between a "standard" stationary model and a non-stationary one. Fractionally integrated autoregressive moving average (FIARMA) processes have been widely and successfully used as a parametric model of univariate time series exhibiting long range dependence. Vector and functional extensions of these processes have also been considered more recently. Here we extend this class of models to processes valued in a separable Hilbert space. In such a framework, the usual univariate long memory parameter d is replaced by a long memory operator D acting on the observation space. This operator is used as the exponent of the fractional integration filter expressed in the spectral domain and is assumed to be a normal operator. We obtain consistency results for the parametric estimation and prediction of FIARMA processes valued in a Hilbert space.

Jamel Saadaoui

Title: *Asymmetries in the oil market: Accounting for the growing role of China through quantile regressions*.

Abstract. This paper investigates the role of political tensions between the US and China and global market forces in explaining oil price fluctuations. To this end, we rely on quantile regressions-quantile autoregressive distributed lag (QARDL) error-correction model-to account for possible asymmetric effects of those determinants, depending on both the level of oil prices and the period. Our results show evidence of a quantile-dependent long-term relationship between oil prices and their determinants over the 1958-2022 period, with an exacerbated effect of US-China political tensions in times of high oil prices. Furthermore, this quantile-dependent co-integrating relationship is time-varying across quantiles, highlighting the increased role played by China in the oil market since the mid-2000s.

Suhasini Subba Rao

Title: *Testing for correlation between different frequency bands of a multivariate time series*.

Abstract. Almost 20 years ago, empirical observations from the neuroscience community suggested that different frequency bands of an EEG could be dependent. This pioneered the research of Hernando Ombao, Sofia Olhede and their collaborators, who proposed the periodic, locally stationary time series. Motivated by these observations and results, in this talk we propose a formal method for testing for correlation between different frequency bands of a multivariate time series under the premise that the underlying multivariate time series is periodically locally stationary. These results can be used to test for periodic stationarity, local stationarity and periodic, local stationarity and allow one to construct a connectivity network.

Rainer von Sachs

Title: *Smoothing covariance and spectral density matrices of multivariate locally stationary time series preserving positive-definiteness*.

Abstract. In this talk we treat statistical inference (smoothing, confidence regions, etc.) for intrinsic wavelet estimators of curves - over time and/or frequency - of covariance or spectral density matrices preserving positive definiteness. The key to success is developing linear and non-linear wavelet thresholding on the Riemannian manifold of the considered matrices.
Our second-generation wavelet estimators are based on average-interpolation and allow the same powerful properties, including fast algorithms, known from nonparametric curve estimation with wavelets in standard Euclidean set-ups. Moreover they enjoy various equivariance properties (e.g. permutation-equivariance with respect to the underlying time series components). We derive rates of mean-squared error consistency and, in

a particular set-up, also asymptotic normality of linear thresholding schemes, including explicit expressions of their asymptotic variance. This allows constructing asymptotic confidence regions which we compare with a proposed bootstrap scheme for inference. Detailed numerical simulations confirm the appropriateness of our suggested inference schemes. Finally, time permitting, first empirical results for more adaptive non-linear threshold estimates will be discussed, too.

Jean-Michel Zakoian

Title: *Inference on multiplicative component GARCH models without any small-order moment*.

Abstract. In GARCH-mixed-data sampling (GARCH-MIDAS) models, the volatility is decomposed into the product of two factors which often received interpretations in terms of "short run » (high frequency) and "long run" (low frequency) components. While two-component volatility models are widely used in applied works, some of their theoretical properties remain unexplored. We show that the strictly stationary solutions of such models are not only weakly nonstationary: they do not admit any small-order finite moment, contrary to classical GARCH. It is shown that the strong consistency and the asymptotic normality of the Quasi-Maximum Likelihood estimator hold despite the absence of moments. Tests for the presence of a long-run volatility relying on the asymptotic theory and a bootstrap procedure are proposed. Our results are illustrated via Monte Carlo experiments and real financial data.

In Memoriam Bernard Desgraupes

Born in Paris on May 15, 1954, Bernard Desgraupes, a lecturer in the Department of Mathematics and Computer Science at the UFR SEGMI, from the 1980s until the end of September 2021, the date of his retirement, passed away on November 14, 2022, after a year and a half of intense struggle against illness.

Son of Madeleine Blum and Pierre Desgraupes (who is likely to be remembered with emotion by the oldest among us since he was one of the founders and enlightened leaders of French television), Bernard was a man of immense mathematical, musical, and literary culture, whose characteristics were modesty and gentleness.

A former student of the "École Normale Supérieure de la Rue d'Ulm" with aggregation in mathematics, Bernard defended a thesis in harmonic analysis on the "homogenization of partial differential equations" and joined the University of Nanterre in the 1980s. Throughout his career, he showed exemplary rigor in his interest in computer tools that could assist researchers in their work. As a teacher and researcher dedicated to serving others, more concerned with pedagogy and transmission than with his own research, he developed numerous computer tools for mathematics and statistics for the scientific community, in the form of manuals and books that are frequently cited (french LaTeX manuals, Tcl/Tk, Python, a best-selling book on R, several works on regular expressions), as well as many programs or packages in Python or R available on the CRAN. Some programs, such as the R package clusterCrit for clustering, have become references. In his final year, he was still developing an R package illustrating and implementing for the first time bootstrap methods for dependent data with Ania and Patrice. He was supposed to be part of the organizing committee of this conference.

His courses, which can be previewed on his web page at https://bdesgraupes.pagesperso-orange.fr/, are models of pedagogy and rigor. They were regularly praised by students who benefited from Bernard's attentive and benevolent ear.

But Bernard was not just a teacher-researcher concerned with sharing his knowledge of mathematics. He was also a music enthusiast, himself a pianist, cellist, and harpist, as well as a composer (including small pieces for harp), orchestrator (of fables by La Fontaine set to music by Lecocq and Offenbach), and a recognized conductor, specializing in 20th-century music, who made it a point of honor to widely disseminate contemporary music.

In 1985, he founded the Erwartung ensemble (named after Schoenberg's work). For twenty years, he performed with his musicians, and his friends, at the most prestigious festivals: Festival of Sacred Art, Autumn Festival in Paris, Lille, Aix-en-Musique, Mostra in Venice, Alicante, Presence at Radio-France, Grame in Lyon, Evian, Berlin, Madrid, Moscow, and many others. His dual training as a musician and mathematician enabled him to approach contemporary works of extreme difficulty. In his recordings with the Erwartung ensemble, he accompanied famous performers and, as a tireless researcher, made us discover little-known works by Satie (Socrates, the Trap of Medusa), Ducrey, Jolivet, Villa-Lobos, Milhaud as well as contemporary musicians who would become famous: Sciortino, Escaich, Tanguy, Ducol... You can listen to some pieces of Satie by Bernard and the Erwartung ensemble here.

In 1989, at the Opéra Comique, he accompanied Elisabeth Söderström in memorable performances of Poulenc's "La Voix Humaine" (one of the most beautiful moments of his career as a musician according to his own words). In 1995, he founded the Opus Opera Company, which produced and/or rediscovered 20th-century chamber operas. In 1998, he notably resurrected Malipiero's Don Giovanni, which earned unanimous praise from the press. His concert devoted to the Japanese composer Yoristsune Matsudaira in 2004, before the dissolution of the Erwartung ensemble, a victim among other things of successive and failing cultural policies of the State, will remain in the annals of music.

Bernard was an indefatigable transmitter of ideas, mathematics, and music, with absolute rigor and discretion, a firm hand in a velvet glove. His colleagues, friends, and the entire MODAL'X laboratory join in the sorrow of his family, especially his two daughters.

Das Licht wird für alle kommen… aber ich allein in meiner Nacht?… Der Morgen trennt uns… immer der Morgen… So schwer küßt du zum Abschied… wieder ein ewiger Tag des Wartens… Oh du erwachst ja nicht mehr… Tausend Menschen ziehn vorüber… Wo bist du? (Erwartung : Marie Pappenheim, Arnold Schoenberg).